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GEOLOGICAL SURVEY OF ALABAMA

CIRCULAR NO.1

Documents showing the nature of the work done by the U. S. Geological Survey in the states.

By

Eugene A. Smith

1895

Circular

Geol. Surv. of Ala.

Dept. 2

SEP 22

DOCUMENTS SHOWING THE NATURE OF THE WORK DONE BY THE U. S. GEOLOGICAL SURVEY IN THE STATES.

The following extract from the Testimony of Maj. Powell, then Director of the U. S. Geological Survey, before a Congressional Committee, printed in Senate Document 82, Forty-ninth Congress, 1st Session, page 35. together with the letter of Prof. Walcott, present Director of the Survey, will show what kind of work the U. S. Survey is carrying on in the States, and what may be expected of it in the near future:

[EXTRACT.]

Major Powell: I do not attempt to go into the States where beds of phosphates are; I do not go into the States and say on what particular land iron is to be found, or on what man's land coal is to be found, or any other mineral; I do make a topographic survey, and upon that place the geologic formations, and then discuss the relations of the iron, and copper, and zinc, and phosphates, etc., to those particular geologic formations. At that point the State Surveys come in and fix the values, methods of development, and other questions, of the several articles, by their own organizations. Upon that plan the States are reorganizing their surveys.

[COPY OF LETTER.]

Washington, D. C., Dec. 19, 1894.

Prof. E. A. Smith, University, Ala.:

Dear Sir—In reply to your letter of December 16, I beg to say that the U. S. Geological Survey is not engaged in the same geologic work as the State Survey, and that it will be many years before the Survey of Alabama by the National Survey will be completed.

I have recently prepared an address upon the subject of the Federal Geological Survey, that section of it which has reference to co-operation with State Surveys is here quoted as follows:

CO-OPERATION WITH STATE SURVEYS.

The attitude of the Federal Survey towards the State Surveys has been in the past to co-operate fully and freely, though commonly in an informal way, and it has uniformly encouraged the institution of State Surveys.

It has been disposed to encourage a division of labor, whereby the economic problems of a local character would be dealt with chiefly by State Surveys, while the more general and usually inter-state problems, which State Surveys have difficulty in dealing with, receive the special attention of the Federal Survey; the latter including triangulation, topography, paleontology, and special researches, requiring time, labor, and specialists. The Federal Survey discusses the relations of the various mineral resources, such as iron, copper, phosphate, etc., to particular geologic formations; then the State Surveys come in with their independent organizaions and fix the values, methods of development, and other questions relating to the local geology and mineral resources. Partial co-operation between the Federal Survey and several State Surveys has been thus effected, the States making use of the results in their State work, and in return furnishing the Federal Survey with data resulting from their more restricted and detailed economic work. . . . . If agreeable to the States, co-operation will be continued on essentially the same conditions in the future as in the past.

The several questions which you ask, I will answer in the order in which they are put:

(1) Attention to the economic geology will be of a general character, as indicated above.

(2) I hope to resume topographic work in Alabama another year, if the appropriation will permit.

(3) If geologic work is taken up, it will be by one party in the north-western section of the State. Under existing financial conditions, it is doubtful if the appropriation for the National Survey will be increased, hence I do not look forward to doing any more work than is above outlined in Alabama for two or three years to come.

(4) The work if taken up will be carried out in the same

manner as in the geologic folios that have already been issued, for it is not within the scope of the Federal Survey to work out all economic geology in the detailed manner that would be proper and desirable in a State report.

Yours truly,

CHARLES D. WALCOTT,
Director U. S. Geological Survey.

During the twelve years that have elapsed since its organization, the U. S. Geological Survey has made maps, on the scale of half an inch to the mile, of about 1-5th of the total area of Alabama. On these sheets are shown the towns, post-offices, railroads, streams, elevations, and other topographic features. The geology has been worked out only in a very small proportion of this area, and as yet none of it is shown upon the maps. If the work were to go on in the future as rapidly as it did at first, we should have in about 50 years the topographic base map completed, and in 10 or 20 years more the geologic map. Upon the map would be shown just about what is shown on the Geological Map of the State just issued by the State Survey. The descriptive matter would be of a general, synoptical nature, and the economic resources would be touched upon only in the most general way; in far less detail, in fact, than is done on the Chart which accompanies the State Geological Map above mentioned.

But since the reduction of the amount appropriated for the U. S. Survey, several years ago, *no work of any kind has been done in Alabama* by that Survey, and nothing beyond the possible completion of some of the topographic sheets already partly surveyed, can even be hoped for, unless the appropriations should be increased by Congress, and this the Director considers doubtful.

EUGENE A. SMITH.

UNIVERSITY OF ALABAMA,
January 15, 1895.

GEOLOGICAL SURVEY OF ALABAMA

CIRCULAR NO.2

Abstract of Alabama clay tests.

By

Eugene A. Smith

18

[illegible]

No. 2233

GEOLOGICAL SURVEY OF ALABAMA.

The following abstract of the results of some tests chemical and physical made of Alabama Clays by Dr. Heinrich Ries, Specialist on Clays to the U. S. Geological Survey, is published in advance of the detailed report, in order that the attention of those interested in clays and the products therefrom, may be earlier [illegible] in this circular. The detailed report above referred to, is now nearly ready for

J. W. Williams, Pegram	69.93	20.15	5.90	1.35	.42	tr.	tr.	1.2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flintclay, Choctaw County	86.30	5.12	6.60	1.60	.46				2.06	15.0	5		22.	6.	2300	2500	2650	yell.	lean.	1.70
MISCELLANEOUS.																				
7 miles north of Fayette C. H.	75.70	14.36	4.45	4.64	tr	tr		1.23	4.64	28.0	45	5.5	6	3	2100	2250	2400	buff	lean.	2.26
W. J. Beckwith, Colbert County	58.20	29.36	9.12	2.24	.27	tr.	tr.	1.18	2.41	28.0	22	35	5.	6.	2050	2250	2150	buff	lean.	2.18
Glen Allen, Marion County	68.10	21.892	5.05	2.008	.80	.28	.40	.70	1.188	28.0	56	65	8.3	7.	1900	2150	2350	lt. buff	fair.	2.44

GEOLOGICAL SURVEY OF ALABAMA

EUGENE ALLEN SMITH, *State Geologist*

FEB 18

CIRCULAR NO. 3

CONCERNING OIL AND GAS IN ALABAMA

By
EUGENE A. SMITH

UNIVERSITY, ALABAMA
1917

BROWN PRINTING CO. MONTGOMERY.

CONCERNING OIL AND GAS

THE striking of a small pool of oil in a deep well at Cordova in December, 1916, has aroused such an interest in the oil and gas possibilities and probabilities of the State that it has been thought desirable to bring together and publish a few notes concerning the occurrence of oil and gas in general, and to review what is known and what may reasonably be inferred concerning their occurrence in Alabama in particular.

I.

ORIGIN AND DISTRIBUTION OF OIL AND GAS.

The theories concerning the origin of oil and gas are the inorganic and the organic, or combinations of the two.

The *inorganic* theory accounts for the formation of oil and gas by chemical reactions which take place without the aid of living organisms. The organic theory assumes that the chemical reactions, resulting in the formation of oil and gas, take place in connection with the decomposition of some forms of organic matter, vegetable or animal. The *organic* theory seems to be the one most generally accepted, but it is admitted that the precise reactions by which organic matters are converted into oil and gas are not definitely known in every detail. In whatever way produced, experience has shown that the strata in many parts of the world are more or less filled with oil and gas. The porous, open grained strata, like sands, sandstones, conglomerates, dolomite rocks, hold much more of these products than close grained shales, clays and limestones. Through the porous rocks oil, gas and water circulate slowly under the influence of gravity and other forces. If the porous rocks or sands are oil-saturated merely, it is not necessarily the case that there will be accumulations of economic value, for there are some other vital points in applied geology as related to petroleum. These have been summarized by Dorsey Hager in his book, "Practical Oil Geology," as follows:

> **"1. Commercial oil and gas deposits occur in the higher parts of folds or wrinkles of the earth's surface called anticlines, domes, monoclines, etc.**
>
> **2. Water is always found in the same stratum as the oil, but in the lower part of the fold.**
>
> **3. All commercial deposits so far, have occurred in sedimentary or water-laid deposits such as sands, sandstones, conglomerates, shales, and limestones.**
>
> **4. All oil and gas deposits, so far as known, are capped or covered by practically impervious beds of shale, sandstone, limestone; also such deposits are underlaid by impervious beds."**

The impervious beds above and below the oil sands prevent the indefinite diffusion of the oil and gas. If the sands holding these are horizontal, the water will be found at the bottom of the sand, the oil and gas above it in the order of their relative weights or densities; but in such flat sands the oil will not be found in paying quantity, since it will occupy only a portion of the thickness of the sands; but it may occupy the whole thickness of the sands and thus be in such quantity as will pay for extraction where the strata are bent upwards into folds or anticlinals, under which at the top of the fold, may be found, first the gas, then the oil, and below them both the water.

In the synclines or downward folds of the strata, water will be found normally occupying the bottoms of the basins, but where the sands are more or less dry, there may be an accumulation of oil in these synclines.

Minor folds along the flanks of a greater anticlinal or synclinal fold may produce secondary anticlines under which oil may accumulate, or in the secondary anticlines thus produced, one flank may be gently the other steeply inclined, and the gently inclined flank may be to all intents and purposes horizontal. Under such conditions terraces may be formed which are important oil reservoirs in many fields.

These relations are shown in the following figures in which the solid black represents the accumulation of oil, over which it may be assumed that there will be more or less of gas. Where the gas is specifically shown in a figure the space occupied by it is left white. The dotted portions of the diagrams represent the porous sands, which, below the oil may be considered as saturated with water, unless otherwise specified.

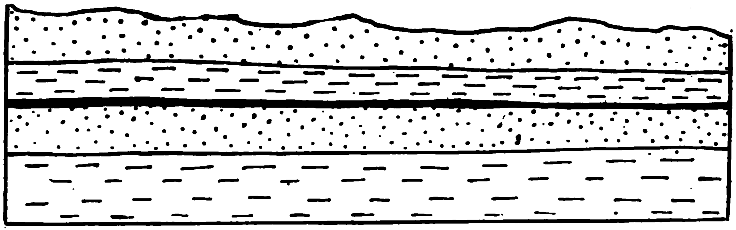


Fig. 1. Showing oil sands in horizontal position, unfavorable to the accumulation of oil in commercial quantity.

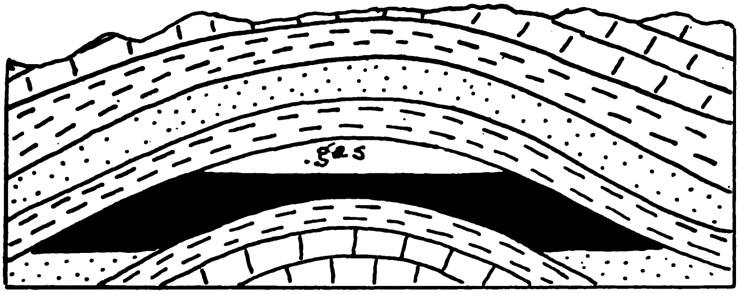


Fig. 2. Accumulation in commercial quantity of oil and gas under an anticlinal fold.

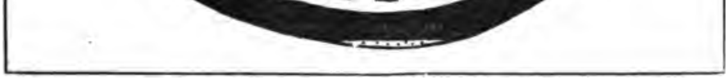


Fig. 3. Synclinal basin in which oil may be found if the porous sands are more or less dry.

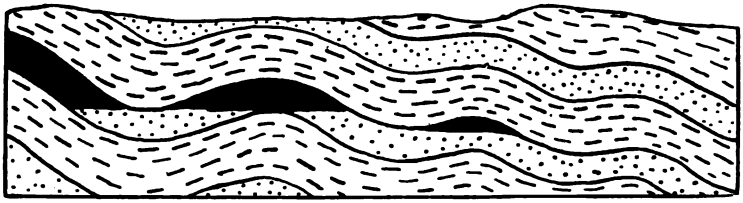


Fig. 4. Showing oil accumulation under minor folds developed along the flank of an anticlinal or synclinal.

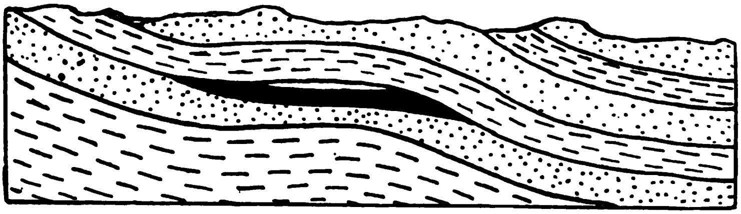


Fig. 5. Oil accumulation on a "terrace."

Oil sometimes accumulates in sand lenses in shale formations, in what are called oil pools illustrated in Figure 6 below.

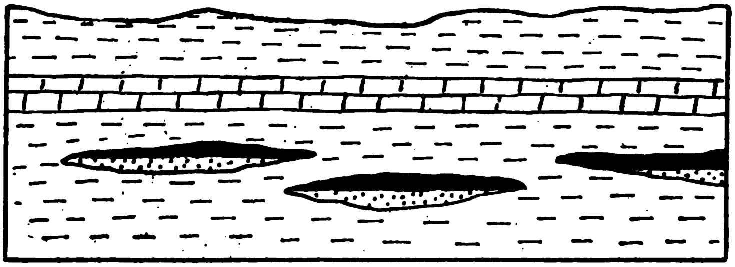


Fig. 6. Oil accumulation in sand lenses in a shale formation; "oil pools."

A divide between the water courses must not be confused with an anticline, which involves the bending up of the strata, while the strata in a divide produced by erosion, may be horizontal or of synclinal structure, in either case unfavorable for the accumulation and retention of oil, as a little consideration will show.

Following are a few statements from Hager's "Practical Oil Geology," which are worthy of consideration:

> "From experience it is known that folds of the strata are important in oil accumulation. Where the folds are exposed at the surface their existence at some depths may be inferred.
>
> 1. All folds do not carry oil.
>
> 2. A geologist cannot tell whether or not a fold will carry oil unless wells are already drilled in it.
>
> 3. He does know that the majority of folds within certain (proven) limits do carry oil, and that the chances are in favor of a well-defined fold being productive if it occurs within certain boundaries."

> Regarding surface indications of oil Mr. Cunningham Craig in his book "Oil Finding," says:
>
> "Actual shows of oil are of great importance; much is to be learned from them, but the study of structure must take first place. As a matter of fact it is very frequently where surface shows of oil are seen that drilling would be entirely unsuccessful, and many of the greatest oil fields known today have not a single surface indication within their length and breadth."
>
> "Surface indications are of various kinds according to the class of oil, the nature of the strata, and the geological structure. They comprise:
> (a) Seepages of oil.
> (b) Asphalt deposits.
> (c) Evolution of gas from gas pools, mud volcanoes, or dry ground.
> (d) Outcrops of bituminous strata.
> (e) Veins of manjak or ozokerite.
>
> "In addition to these the evolution of hydrogen sulphide may be in some cases a favorable indication, and crystals of sulphur in cavities in a rock, or the presence of minute traces of sulphur in flecks and patches may also be important. * * * A faint odor of petroleum may sometimes be detected where no actual seepage can be discovered.
>
> "A stratum which is oil-bearing at one place may not be at another place, just as sediments of different kinds, sands, clays, and vegetable accumualtions are laid down simultaneously along a shore line; hence the impossibility of tracing any oil sand for any great distance."

SOME ALABAMA LOCALITIES WHERE THE GEOLOGICAL STRUCTURE SEEMS TO BE FAVORABLE FOR ACCUMULATION AND STORAGE OF OIL.

APPALACHIAN PROVINCE.

Cincinnati Anticline.

The great anticlinal arch of Ohio, the Cincinnati Anticlinal, extends southward through Kentucky and Tennessee into Alabama where its presence is recognized by the outcrops above drainage, of Silurian and Ordovician strata along Flint River in Madison, Limestone Creek and Elk River in Limestone, and Blue Water and Shoal creeks in Lauderdale near the Tennessee line. On this anticlinal and especially along its flanks occur in Ohio and West Virginia some of the most important gas and oil wells of the country. In Northern Alabama from Madison and Morgan counties westward the phenomena accompanying oil and gas are numerous. These are occurrences in all the counties included, of natural gas, tar springs, bituminous sandstones, bituminous limestones, and petroleum. Borings at Huntsville have yielded some gas which has been utilized to a limited extent in the city. In Morgan County in section 30, township 7, range 6-W. are the Goyer wells sunk many years ago in search of oil, of which a small amount was struck. The report of the Alabama Geological Survey on the Tennessee Valley Region by Henry McCalley, gives abundant details of all these occurrences.

Within the limits of the coal field in Marion, Franklin and Fayette counties there are also evidences of oil and gas at Atwood in Franklin, and Hamilton in Marion where the cores of diamond drill have brought up oil-saturated sands, and near Fayette Court House in the county of the same name are gas wells that have been active for a number of years and which have yielded gas in commercial quantity to the town of Fayette.

Bulletin No. 10 of the Geological Survey is devoted to this Fayette County gas region.

From the above it may be seen that this region of Alabama over the arch which represents the termination of the great

Cincinnati anticlinal, should by analogy be favorable for oil and gas prospecting.

Democrat Ridge.

The great Sequatchee—Blount Springs Valley, extending northeast and southwest from Alabama into Tennessee, is in the valley part, an eroded anticlinal. The unbroken anticlinal uplift beyond the northeastern end of the valley in Tennessee is the Crab Orchard Mountain, the corresponding extension of the valley in an uneroded uplift to the southwestward is known as Democrat Ridge. This well defined anticlinal uplift may be followed easily southwestward from Ried's Gap down through Jefferson, and probably into Tuscaloosa County. It is in part the boundary between Jefferson and Walker. Structurally this ridge and its prolongation to the southwest should be promising ground for oil prospecting. Several deep wells near Bryan on the Ridge and at Jasper and near Cordova along the western flank of the uplift, have proven the existence of oil, although as yet not in commercial quantity. A careful study of the geological structure along this uplift and its flanks might well be expected to show promising locations for deep wells.

Northwestern Limb of the Warrior Basin Syncline.

The wide synclinal basin of the Warrior Field, lying between the Democrat Ridge uplift and its prolongation to the southwest on the one side, and the escarpment of Sand Mountain and the termination of the Cincinnati uplift on the other side, is unsymmetrical in that the gentle slopes of the northwestern limb of the syncline cover most of the territory, the axis of the Basin being near its southeastern edge. Along this wide area of the northwestern limb of the synclinal it may be that minor folds are developed which afford conditions favorable for oil accumulation such as yield a great portion of the oil and gas of Pennsylvania and West Virginia. Fig. 4 above would illustrate such subordinate folds on a limb of a great synclinal.

The Appalachian Valleys.

In the great Coosa Valley Region, and in the outlying anticlinal valleys, Cahaba, Jones, Roups, Murphrees, Wills, and

Blount Springs, erosion has cut down into Ordovician and Cambrian strata in the central part, and the conditions therefore are in general not favorable for oil and gas accumulation.

Along the southeast flank of the Red Mountain bordering ridge of Jones Valley, and between that ridge and the Shades Mountain border of the Cahaba Coal Field, there is the wide valley of Shades Creek, exposing strata of the Subcarboniferous or Mississippian formation. This wide expanse of these rocks can be due only to a flattening of the strata, or a series of faults. In the first case if due to flattening, there would almost inevitably be minor folds produced, favorable to oil accumulation. Similarly, to the east of the Coosa Coal Field the wide area of Subcarboniferous rocks may be associated with analogous folds. Those interested in oil prospecting might consider these possibilities.

In the great Coosa Valley region the presence of strike faults and broken folds, would in general, be unfavorable for oil accumulation.

Oil Sands of the Appalachian Province.

The drillings which have brought up some notable shows of oil in this province, have struck these sands in the Pennsylvanian or Coal Measures and the other Paleozoic formations down to the Trenton of the Ordovician.

The Cordova well, which has yielded the largest show of oil finds it in the Coal Measures. It is too early yet to locate productive oil sands in the State.

COASTAL PLAIN PROVINCE.

The two formations which make this part of the State are the Cretaceous and the Tertiary.

CRETACEOUS.

The subdivisions of this formation named in ascending order are the Tuscaloosa, the Eutaw and the Selma Chalk.

The *Tuscaloosa* is made up of sands and clays of fresh water origin generally. Some of the strata are plant-bearing.

The *Eutaw* is composed of marine formations in the main, sands and clays, the sands partly calcareous and glauconitic.

The principal rock in the *Selma* formation is a chalk mostly with varying admixtures of clay. Above this chalky part the sandy strata of the *Ripley* are in evidence, especially in the eastern part of the State. The upper beds of the Cretaceous are generally sandy but they are generally classed with the chalk on account of the similarity of their fossils.

Where these beds of the Tuscaloosa and Ripley are of estuary origin they should be suitable for oil production.

Prairie Bluff.

At the Prairie Bluff ferry and landing and at Rock Bluff, a mile above the warehouse landing, we find a decided and relatively steep dip of some of the strata. Both at Prairie Bluff and at Rock Bluff, the strata at the top of the Bluff lie nearly horizontal, while those constituting the lower halves of these bluffs show the high angle of dip. Between the two series there is thus apparently an erosional unconformity, unless the high angle of dip of the lower strata is the result of cross bedding on a large scale. It might be worth while for oil prospectors to look more closely into this instance of a very sudden change in the angle of dip, as possibly affording the conditions favorable to the accumulation and storage of oil.

TERTIARY.

The formations making up the Tertiary of Alabama in ascending order are the Midway, the Chicasaw or Wilcox, the Buhrstone, the Claiborne and the St. Stephens, above which are the Grand Gulf beds as originally defined by Dr. Hilgard.

These contain estuarine deposits at many horizons, and with favorable structure conditions, there should be many oil sands in the formation.

Hatchetigbee and Jackson Anticlinals.

While engaged in the mapping of the Alabama Coastal Plain during the years 1883-87, the present writer and his Assistant, D. W. Langdon, located and mapped two well-defined anticlinals in the Tertiary terranes, viz., the Hatchetigbee and the Lower Peach Tree uplifts. At the same time at several points southward of Jackson in Clarke County unconformable contacts were noticed of Vicksburg and Jackson limestones with underlying formations showing some comparatively recent crustal movements in that section.

In 1905 this region was investigated for the Geological survey by Mr. S. A. Hobson, whose map of the Jackson Anticlinal is given in Fig. 8 below, along with his cross section Fig. 9 explanatory of the structure.

The map Fig. 7 copied from our Geological Map of 1894, but revised for the Jackson Anticlinal, will serve to show the locations of the anticlinals above named. The Hatchetigbee anticlinal may be traced from Bladon Springs nothwestward towards Shubuta in Mississippi, and southeastward into Clarke County, Alabama, towards Jackson, and southward of Jackson there is what appears to be a continuation of the anticlinal down as far as Oven Bluff on the Bigbee River. Along the southern flank of the Hatchetigbee anticlinal through Choctaw and Washington counties, there are many interesting occurrences of salt seeps and gas escapes. In Clarke County also along the Jackson anticlinal are similar phenomena. At several places in Clarke County as well as in Washington deep wells as well as shallow ones have afforded brine from which salt was extensively manufactured during the strenuous times of the Civil War. Almost anywhere along these anticlinals escapes of inflammable gas are numerous. Of late years several deep wells have been put down along the lines of these anticlinals without success so far as the bringing in of commercial quantity of oil is concerned, though in one instance at least there seems to be no doubt that a small quantity of oil was struck. These anticlinals, none the less, seem to be most promising localities for future tests for oil, and it is altogether probable that a closer study of the structure than has yet been given to this area, may point out the places where test wells should be sunk with the best chances for finding oil. It is doubtful if any of the deep wells up to the present time have been located with special reference to the details of geological structure.

The accompanying map and cross section of the Jackson anticline are here given as representing the present interpretation of structure and distribution of the formations involved. Further investigations by this Survey now in progress may modify in some respects the views expressed below.

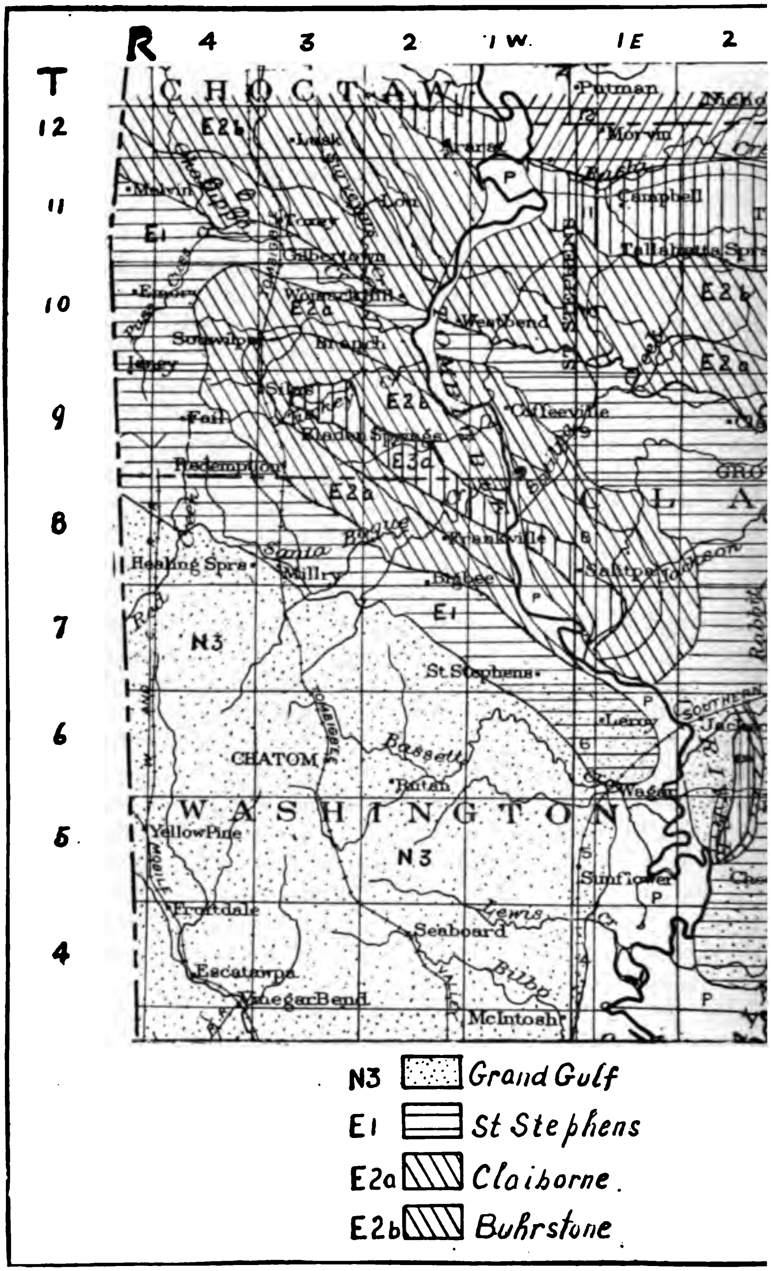
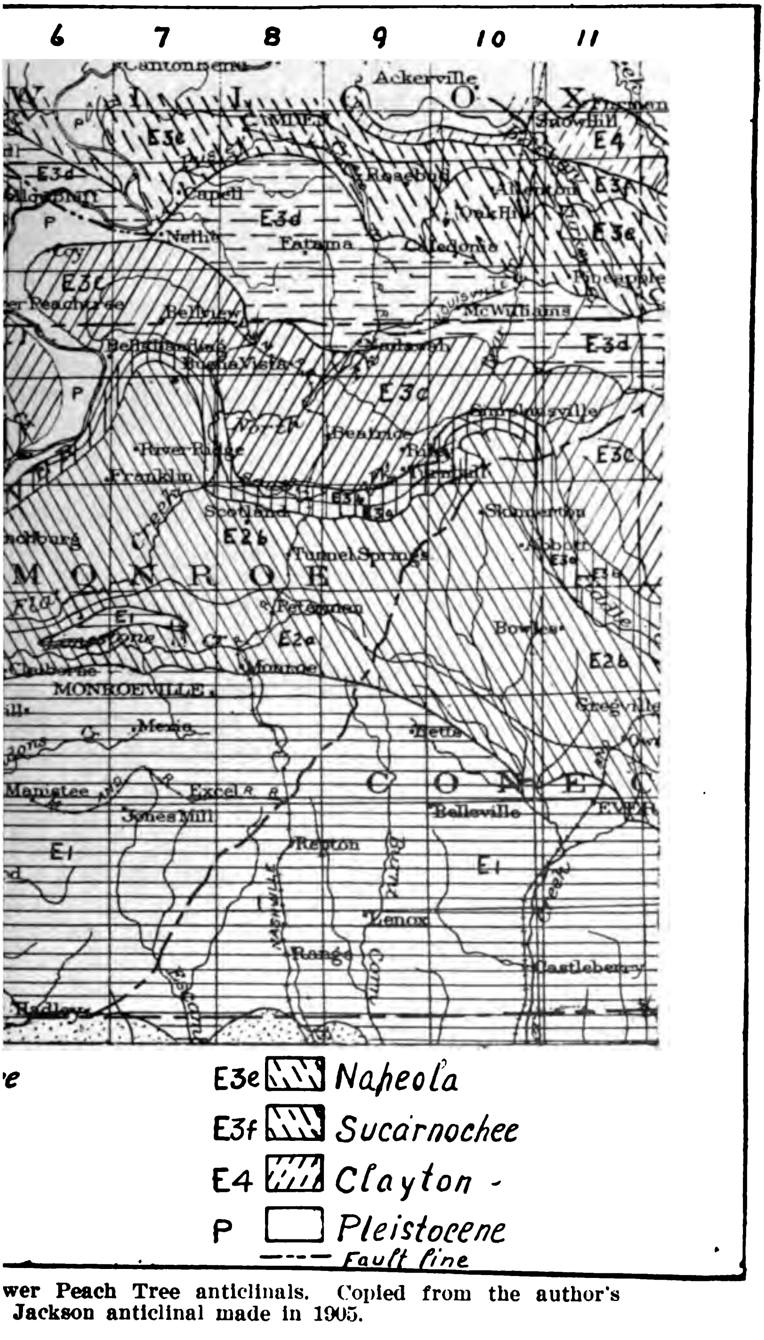


Fig. 7. Geological map of part of Alabama, **including the** geological map of 1894, **with the**



wer Peach Tree anticlinals. Copied from the author's Jackson anticlinal made in 1905.

Some of the peculiarities in the Jackson anticlinal may here be mentioned in connection with the explanation offered by Mr. Hobson: The Orbitoidal limestone of undoubted Vicksburg age may be seen in places resting directly upon the clays and sands of the Hatchetigbee, while in other places not far distant, this limestone rests upon the thin remnant of Buhrstone which there shows between the Hatchetigbee and the Vicksburg. In other places it is the Jackson limestone which is directly upon the Hatchetigbee. The two sides of the anticlinal, so far at least as the strata are exposed, show marked differences. On the east this succession is usually more complete, especially towards the northern end of the anticlinal. Towards the lower end, however, the irregularities in the way of missing or thinned down formations are more in evidence. On the western side, on the other hand, none of the strata involved are seen except the Vicksburg limestone, which in the most westerly exposure, rests upon the Hatchetigbee, which is the lowest of the formations involved in the uplift. A possible explanation of this is that the crest of the anticlinal lies to the west of any of the exposures of the Tertiary rocks where it is hidden by more recent formations, or possibly in addition to this, the erosion of the valley of the river may have removed much material, and thus lowered the level of the Tertiary rocks below the reach of observation. It is very probable that some of the unconformities are due to faults.

Many of the phenomena of this anticlinal we cannot clearly explain, but it seems evident, as Mr. Hobson has suggested, that after the deposition of the lower Tertiary formations, up to and including the upper Claiborne, came the wrinkling of the strata into the anticlinal fold, then the denudation of its crest down to the Hatchetigbee clays. In this erosion the next overlying Buhrstone and Claiborne were thinned down to sharp edges towards the center of the anticlinal.* Then came a depression and a transgression of the Jackson and Vicksburg seas continuing through both periods, and allowing unconformable deposition of the characteristic limestones of these

---

*In going from the Lower Salt Works up the old road to Cherry, one crosses successively the outcrops of Buhrstone, Claiborne and Jackson to the Vicksburg. The Buhrstone here shows a thickness of only 75 feet, the Claiborne, by only 3 or 4 feet, the Jackson and Vicksburg show normally to all appearance.

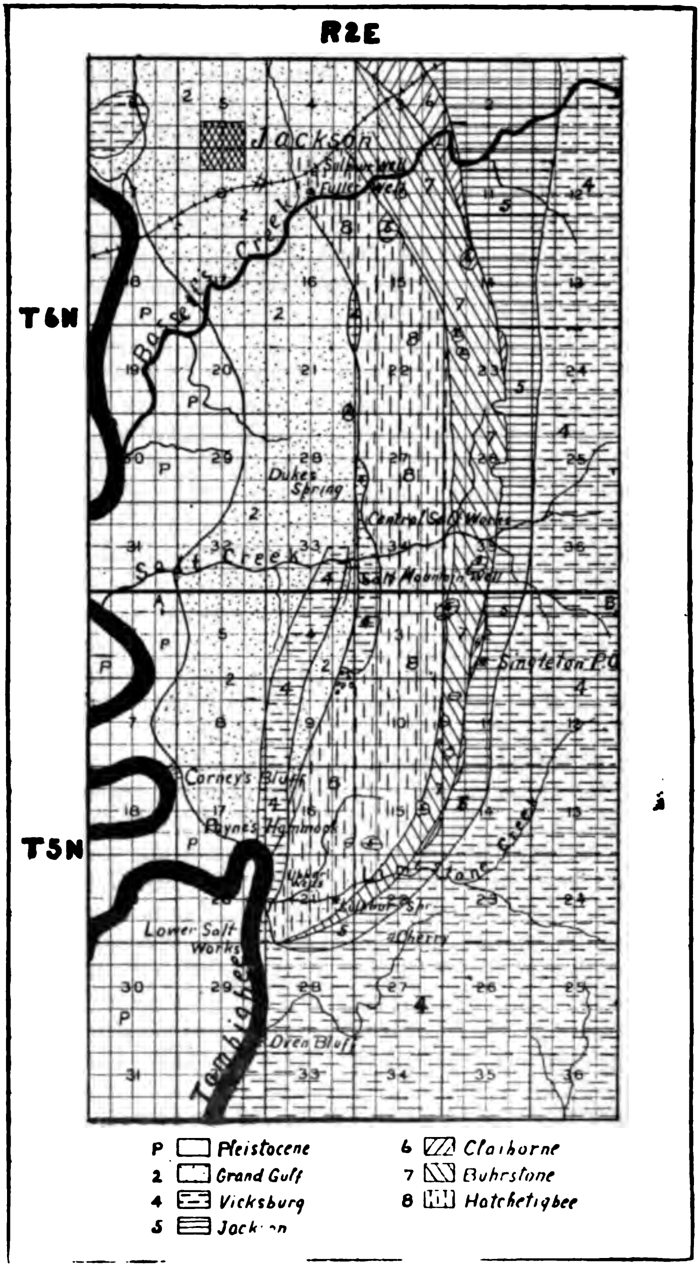


Fig. 8. Map of the Jackson anticlinal by S. A. Hobson, 1905.

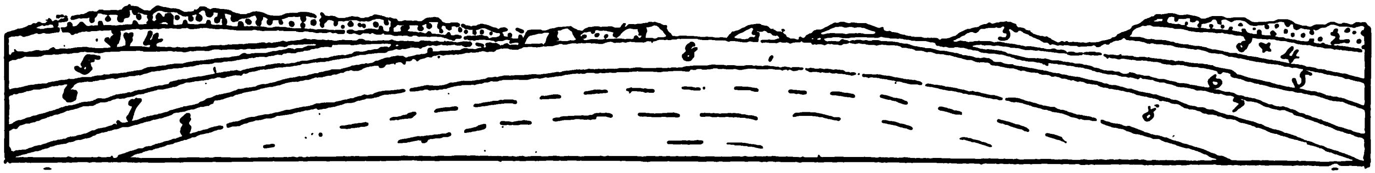


Fig. 9. Cross section of the Jackson anticlinal along the line A-B near the Central Salt Works, showing the thinning down of the Buhrstone and Claiborne beds toward the center of the uplift, and the unconformable contact of the Jackson and Vicksburg strata with the Hatchetigbee and Buhrstone. 2. Grand Gulf. 3 and 4. Vicksburg. 5. Jackson. 6. Claiborne. 7. Buhrstone. 8. Hatchetigbee.

two formations either upon the Hatchetigbee or upon the beveled edges of the Buhrstone and Claiborne. In this transgression the seas during the Vicksburg period extended farther than during the Jackson period, for we find the Vicksburg resting on the Hatchetigbee without any Jackson limestone between. This might perhaps better be expressed by saying that the Hatchetigbee Island was not entirely covered by the Jackson seas, but was later covered by the Vicksburg sea.

Lower Peach Tree Anticlinal.

On the banks of the Alabama River at Bells Landing a certain shell bed is seen at the water level in certain stages of the river. (See map, Fig. 8.) At Lower Peach Tree landing up the river, the same bed occurs at an elevation of 100 feet above average water level. Still further up the river at Yellow Bluff this shell bed is again down to water level as at Bells Landing. Above Yellow Bluff there is a fault of 150 feet displacement, which fault has been traced in a general direction northwest and southeast for 12 or 15 miles. While this anticlinal has not been mapped it is inferred on general principles that the axis of it is approximately parallel with the general trend of the Tertiary formation, which is at this point northwest and southeasterly. So far as I am aware no test wells have ever been sunk on this anticlinal, but on general principles it should be a promising field for testing.

The Coastal Plain report of the Geological Survey contains many details concerning the Hatchetigbee, the Jackson and the Lower Peach Tree anticlinals. Unfortunately, however, this report is practically out of stock, and therefore not available for distribution. So also the large-scale geological map of the State, 1894, which shows these structures, is out of print. A small-scale, generalized copy of this map accompanies the Index to the Mineral Resources of the State, and also the report on Underground Waters, and shows in general the locations of the Hatchetigbee and Jackson folds.

The map, Fig. 7, which covers the area including these three anticlinals, is given here to supply in part the information contained in these out of print documents.

Geneva and Houston Counties.

In the southeastern part of the State, especially in Houston and Geneva counties, while the Claiborne strata are exposed in the banks of most of the streams traversing the counties from north to south, the higher lands are occupied by the strata of the St. Stephens limestone, very often completely silicified. This would indicate the flattening almost to horizontality of the strata, which should be associated with local, minor folds favorable to oil accumulation, and it might be well worth while if those interested in oil would bear these possibilities in mind.

Mobile and Baldwin Counties.

In no part of the State has there been of late greater activity in the line of oil and gas prospecting than in the two coast counties, especially in Mobile. A number of wells have been started on Cottage Hill and surrounding highlands. One of these wells had reached a depth of 2,500 feet a month ago and had passed through 20 feet of very promising oil sands.

Concerning the prospects at these drillings it may be said that the geological formations underlying Mobile County are the same as those which are oil-bearing in Louisiana and Texas, and since oil is very generally distributed in the Tertiary strata, it is as likely as not that some of the underlying strata of Mobile County carry oil in commercial quantity, although it cannot be positively asserted until it has been actually proven by the drill. It must be borne in mind that where oil sands actually exist the oil cannot accumulate in commercial quantity unless the structural conditions are favorable, and it is not certainly known, so far as I am aware, that such structural conditions exist, although we may hope that they do. Where the drillings are located without knowledge of these structural features, and without reference to them, the success of a well is a matter of chance, even if the sands are oil-bearing.

I might add in conclusion that none of the surface indications of oil enumerated above at the end of Part I in quotation from Dr. Cunningham Craig's book on "Oid Finding," have come under my personal observation in Mobile County, but that signifies little, since, as Mr. Craig has said in the book above quoted, "Many of the greatest oil fields known today have not a single surface indication within their length and breadth." With reference to the claim made in some of the advertisements, of the existence of volcanic cinders, gas blowouts, etc., as certain indications of the presence of oil, I may say that there is certainly no evidence of any volcanic activity in Mobile County, but even if there were it would be against the probabilities for oil-finding, since all commercial bodies of oil occur in sedimentary or water laid deposits. Still less do I have any faith in the location of oil pools, or of any mineral deposit, by means of a mineral rod, or divining rod, or by whatever name it may be called.

EUGENE A. SMITH,
State Geologist.

University of Alabama,
June 27, 1917.

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GEOLOGICAL SURVEY OF ALABAMA
EUGENE ALLEN SMITH, STATE GEOLOGIST

CIRCULAR 4

PETROLEUM PRODUCTS IN SHALLOW WELLS IN ALABAMA

BY
WALTER B. JONES, PH.D.
ASS'T STATE GEOLOGIST

UNIVERSITY, ALABAMA
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BIRMINGHAM PRINTING COMPANY
BPCo
PUBLISHERS

LETTER OF TRANSMITTAL

University, Ala., July, 1927.

HON. BIBB GRAVES,
Governor of Alabama,
Montgomery, Alabama.

Sir: I have the honor to transmit herewith the manuscript of a report on the Occurrences of Petroleum Products in Shallow Wells in Alabama, with the request that it be printed as Circular No. 4 of the Geological Survey of Alabama.

Very respectfully,

EUGENE A. SMITH,
State Geologist.

GEOLOGICAL SURVEY CORPS

Eugene Allen Smith, Ph.D.	*State Geologist*
Walter Bryan Jones, Ph.D.	*Assistant State Geologist*
Stewart J. Lloyd, Ph.D	*Geologist*
Robert S. Hodges, D.Sc.	*Chemist*
Roland M. Harper, Ph.D.	*Geographer*
Harry E. Wheeler	*Curator of the Museum*
Mrs. Herbert H. Smith	*Assistant Curator of the Museum*
Elizabeth Jennings	*Secretary*

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INTRODUCTION

SINCE the occurrences of petroleum products in shallow wells have become quite common in recent years, it has been thought advisable to investigate the most recent of the occurrences and make a complete report concerning the facts, as nearly as they can be determined. Fortunately, the Survey has samples from all of the areas reporting these materials, and considerable work has already been done.

The writer wishes to state in the beginning that it is his sworn duty to present to the general public specific facts, without evasion or reservation. This department has been in continuous operation since 1848, and its aim has always been to present more to the prospective investor and operator, than he was led to expect. Often it is not possible to determine accurately the possibilities of any particular ore deposit, but in cases such as the occurrences of gasoline, there can be but one answer. This department has a dual rôle to play. On the one hand, projects which appear to lend themselves to remunerative exploitation are boosted. On the other hand, those which cannot be turned into a modest return or chance for return, on the investment, are summarily dismissed or relegated to the uncertain columns. So far as the main question is concerned, this department is dismissing forever this gasoline affair and all like affairs which may come up in the future.

Gasolines have a pungent odor, while most crude petroleums have a not unpleasant odor, if any at all. This same thing applies to all refined products which have sufficient lighter components to volatilize. Another valuable point is that gasoline has never been found in nature. The nearest thing to it was an occurrence in West Virginia* where an extremely light crude oil was produced. This crude came from the Otto No. 1 Well, 3 miles northeast of Moundville, and was 63.5 degrees Baumé. One very significant thing about this material, was that it had all the characteristics of crude oil. The San Pedro, Mexico, crude carries 80 per cent gasoline and lighter components, and is 46.6 degrees Baumé. Many of the crudes give off only a few per cent at 300 degrees C. But to find a crude which would give off 99 per cent at 300 degrees C. is something which must be left to future generations. It has not been found in the past.

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*"Petroleum and Natural Gas"—West Virginia Geological Survey, Vol. 1, p. 364.

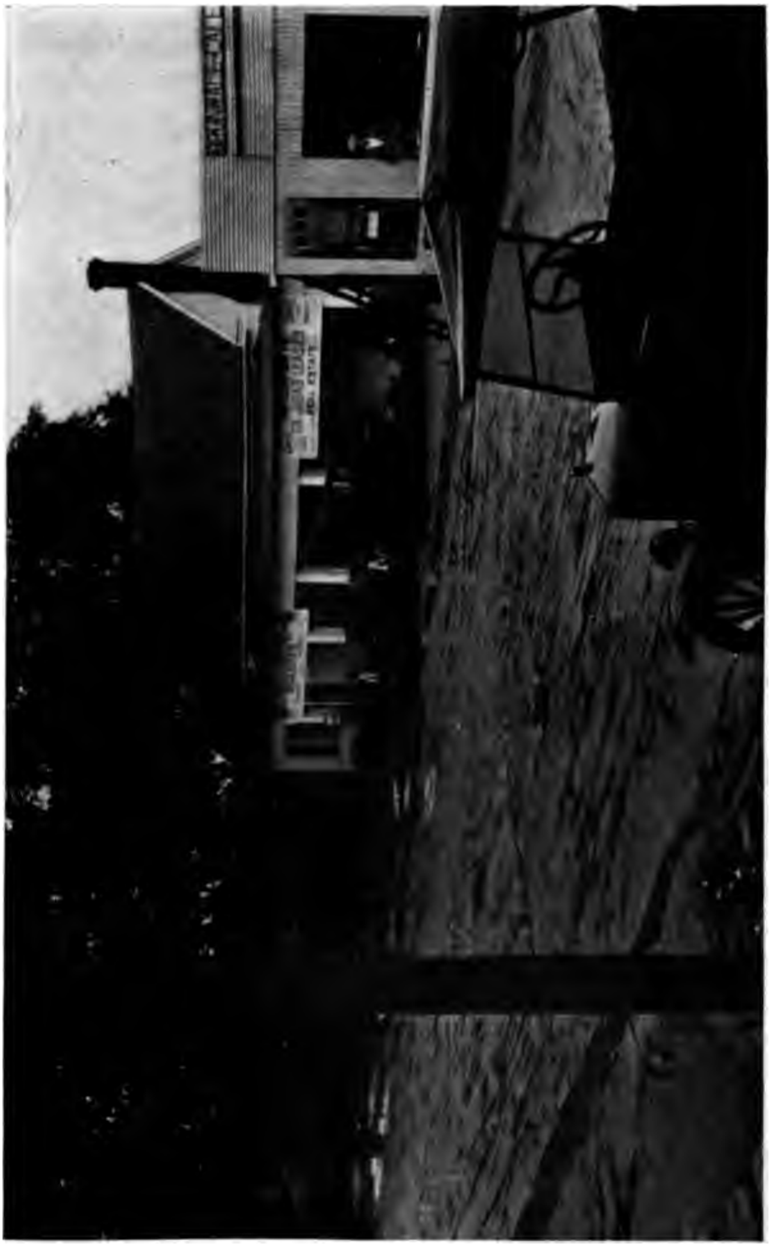
There can be no doubt, therefore, about the accuracy of the findings in this work, and all unbiased citizens in the communities involved, as well as in the State at large, are urged to think carefully over the facts and apparent deductions therefrom, for their own information and perhaps for their own welfare. To invest in such things as these, is to surely lose the entire amount.

It is the contention of the Survey that booms and excited operations, which are fighting overwhelming odds against success, leave in their wake disgruntled and disappointed investors. This is not considered to be in the best interests of the State, and therefore, the Survey would like to avoid as much of this sort of thing as possible. There are too many branches of the mineral industry of Alabama where investments give good returns, and the Survey naturally encourages these things.

The chance of making a killing in the oil game sets the average citizen wild with excitement, as nothing else will. When the cold facts are analyzed, it will be seen that more fortunes are lost than are made. In Alabama alone, something like fifteen million dollars have been invested in prospect wells for oil and gas and the return on the investment is generously estimated at ten thousand dollars.

The policy of the Survey is to encourage rather than discourage prospectors who go about their work deliberately, in an honest effort to find oil or gas in paying quantities, and who locate these prospects in the most favorable territory. On the other hand, the Survey does wish to discourage operations based on such evidence and flimsy excuse as has been presented in the recent booms. The writer is well aware of the real estate scrambles (see Plates 1 and 2) which follow or accompany these periods of excitement, and the infusion of oil experts, promoters and wizard drillers into the game, and that these people are apt to be the only ones to make anything out of it. There have been many instances where men who class themselves as expert drillers from the Pennsylvania or Texas or Oklahoma or some other oil field, come into a region and ride the band wagon in order that funds might be raised to drill a test well, *under their management.* Business men who ordinarily abhor unsafe methods, never seem to be able to see through such projects. The presumption of such

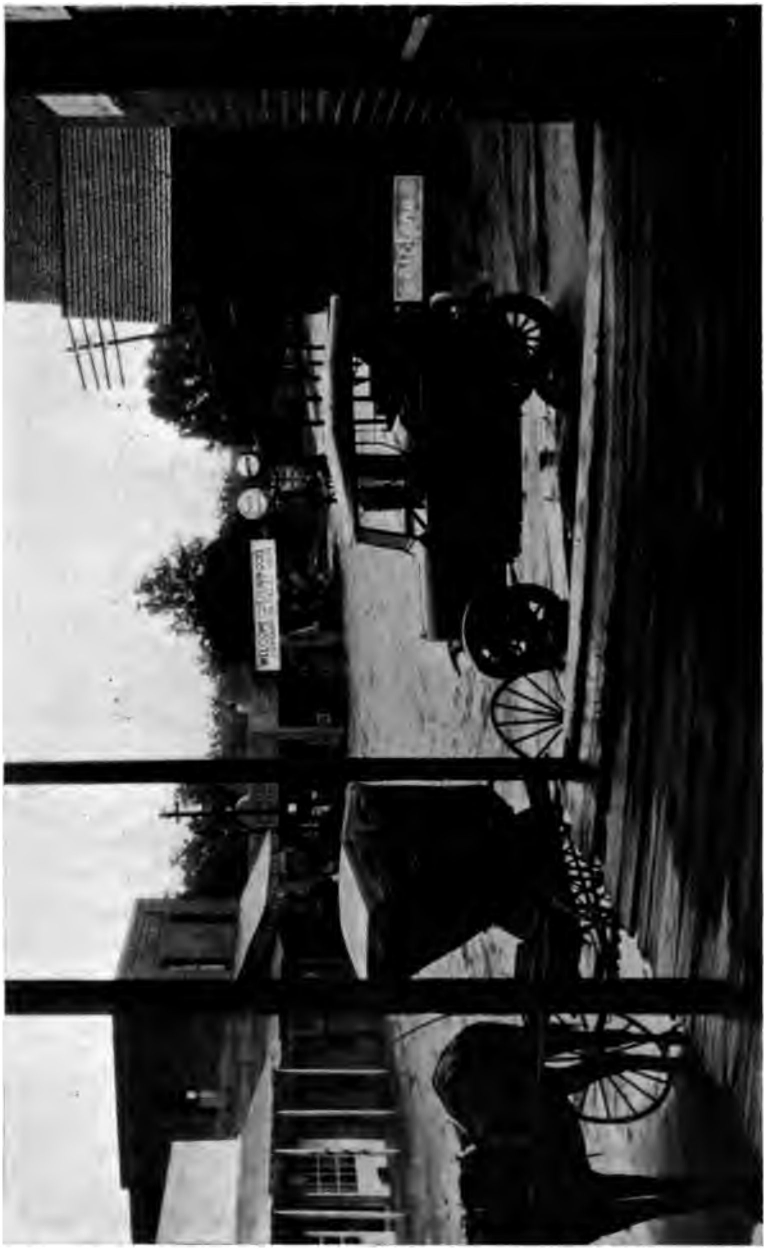
PLATE 1



No. 658. View in Cottonwood, showing temporary offices.

Photo—Dr. Walter B. Jones, June 10, 1927.

PLATE 2



No. 659. View in Cottonwood, showing main street and three filling stations

Photo—Dr. Walter B. Jones, June 10, 1927.

promoters is hardly equalled in any other profession or line of business.

HISTORY

Pell City. The first occurrence brought to the attention of the Geological Survey was at Pell City, in Calhoun County, where a shallow well near the school house had a showing of material similar to gasolines on the market at that time. This occurrence was investigated by Arthur J. Blair, Geologist for the Tennessee Coal, Iron & Railroad Company. Mr. Blair told the writer in conversation recently, that there was no doubt in his mind but that the occurrence was a refined product and not natural. (See figure 1, curves 3 and 6.)

The Pell City occurrence was in clays weathered from limestones of Ordovician age. The rocks in that area are practically on end, and the writer regards the entire section to be without the slightest chance for the occurrence of oil or gas in paying quantities.

Pine Hill. The next area reporting this kind of material was Pine Hill, where a shallow well was said to be making several gallons of the fluid daily. The sample sent to the Survey was remarkably pure, (see figure 1, curve 4) and was found to run automobiles without overheating.

The Pine Hill occurrence differs from that at Pell City in that the general regions is in the second best section in Alabama for oil and gas in commercial quantities. The beds at Pine Hill are Tuscahoma Sands of Eocene age.

Gurley. The third occurrence is at Gurley, in Madison County. This was brought to the attention of the writer on June 25, 1925, and a small sample of the material was given him for analysis. After careful examination of the sample, it was decided that this also was a refined product (see figure 2, curves 3 and 5). Since that time, many samples of the Gurley material have been sent to the Survey. These have varied from almost pure benzine, which obviously had not been subjected to weathering agencies the least bit, to low-grade kerosene. Such a variety of materials could hardly come from the same source, and accordingly the matter was listed as a closed incident. Persistent reports from the

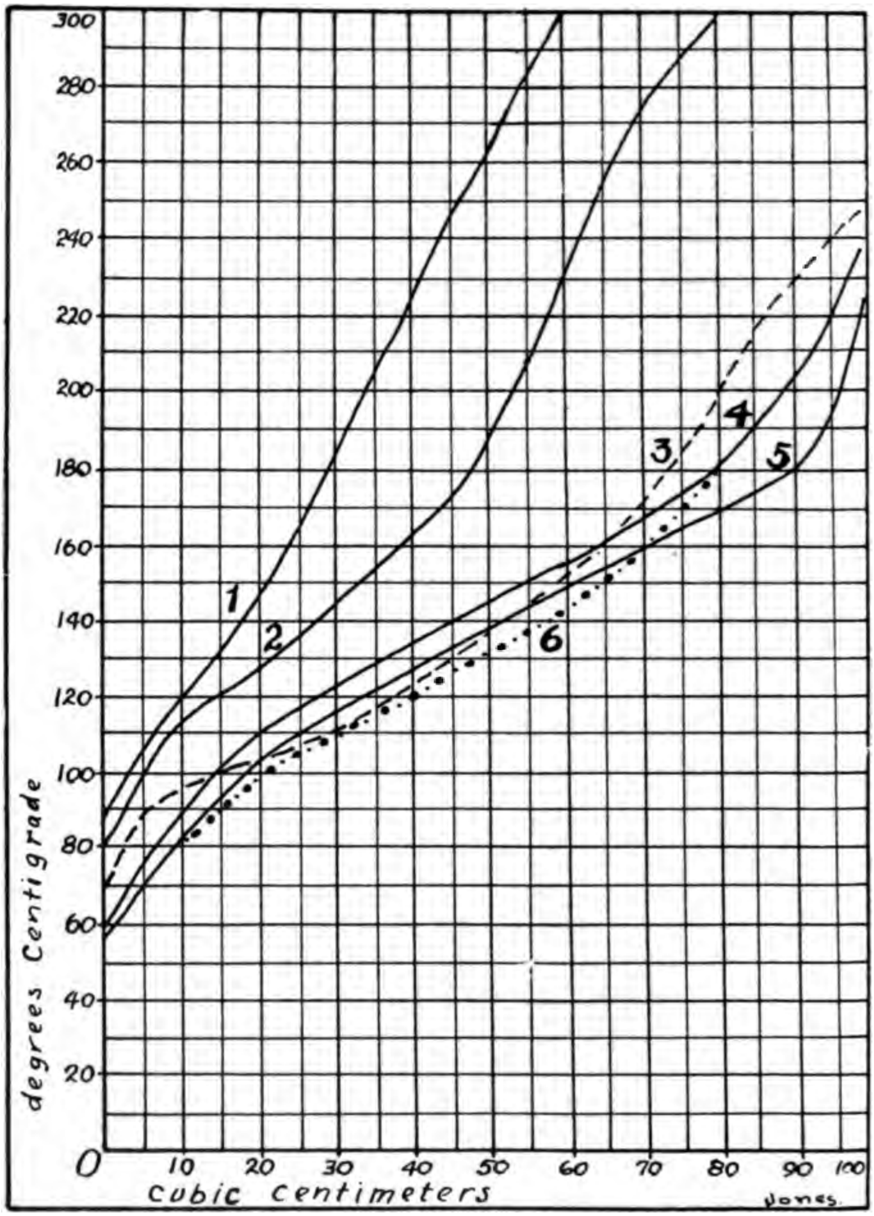


FIGURE 1. *Distillation curves.*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
3. Gasoline from Pell City, Calhoun Co. well.
4. Gasoline from Pine Hill, Wilcox Co. well.
5. A commercial gasoline, fresh from storage tank.
6. Gasoline from Pell City, Calhoun Co. well.

Dr. Robert S. Hodges, Analyst.

region, to the effect that all storage tanks had been taken up and examined, without discovering any leaks, failed to change the inevitable conclusion that the material was refined and thus had no bearing whatever on the possible occurrence of oil and gas in the region.

Gurley is located in an area which is favorable for gas in commercial quantities, but oil is unlikely, in the opinion of the writer. The rocks at that place belong to the Bangor Limestone group of upper Mississippian, and the Trenton can be easily reached by the drill.

This occurrence is given a different aspect from the others, however, by the fact that a well is now being drilled by the citizens of the community to prove or disprove the source of this material. The writer predicts that the well will not be successful, since it was not located with regard to structure, but because of the pollution of shallow wells in the vicinity by gasoline.

COTTONWOOD

The latest occurrence to be personally investigated by the author is that at Cottonwood. The accompanying sketch (see figure 3) will show the general lay-out of the town, and its polluted water wells. It appears that this was first noticed about ten years ago when the well now listed as Johnnie Bruner's, showed some fumes during the process of cleaning it out. The first definite recognition, however, was when S. A. Barker collected some of the material from his well at the grist mill, and set it on fire. This was more than a year ago.

The writer had seen several notices of the occurrence in various newspapers, but his first definite information was contained in a letter from Mr. Herman Gunter, State Geologist of Florida. Mr. Gunter visited the place in company with Dr. L. C. Snider of the Henry L. Doherty Company, late in May. It might be well to state here, by the way, that Dr. Snider regarded the occurrence as one of escaping gasoline, and remarked that there are innumerable such happenings throughout the extent of the operations of his Company. This account of Mr. Gunter's was accompanied by a sample, which was analyzed by Dr. Hodges (see figure 4, curve 2) and found to be a refined product, similar in every way to

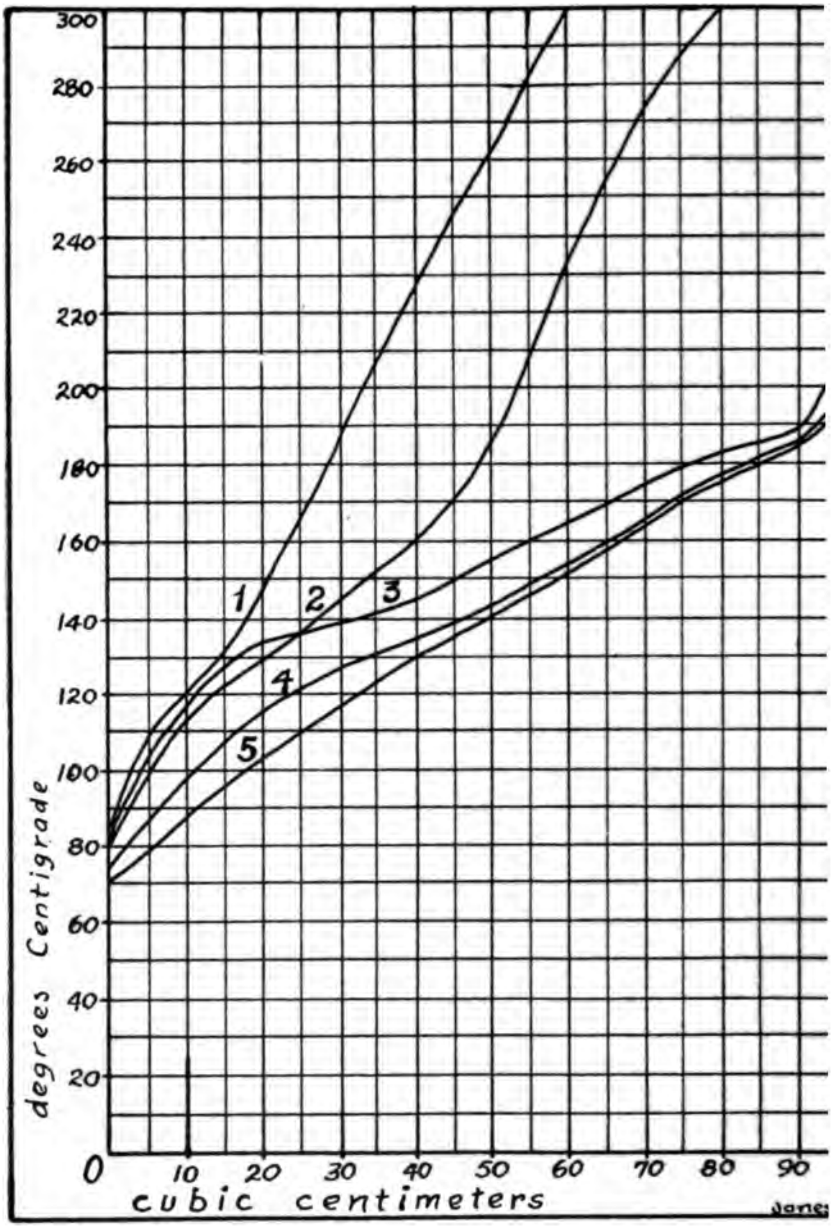
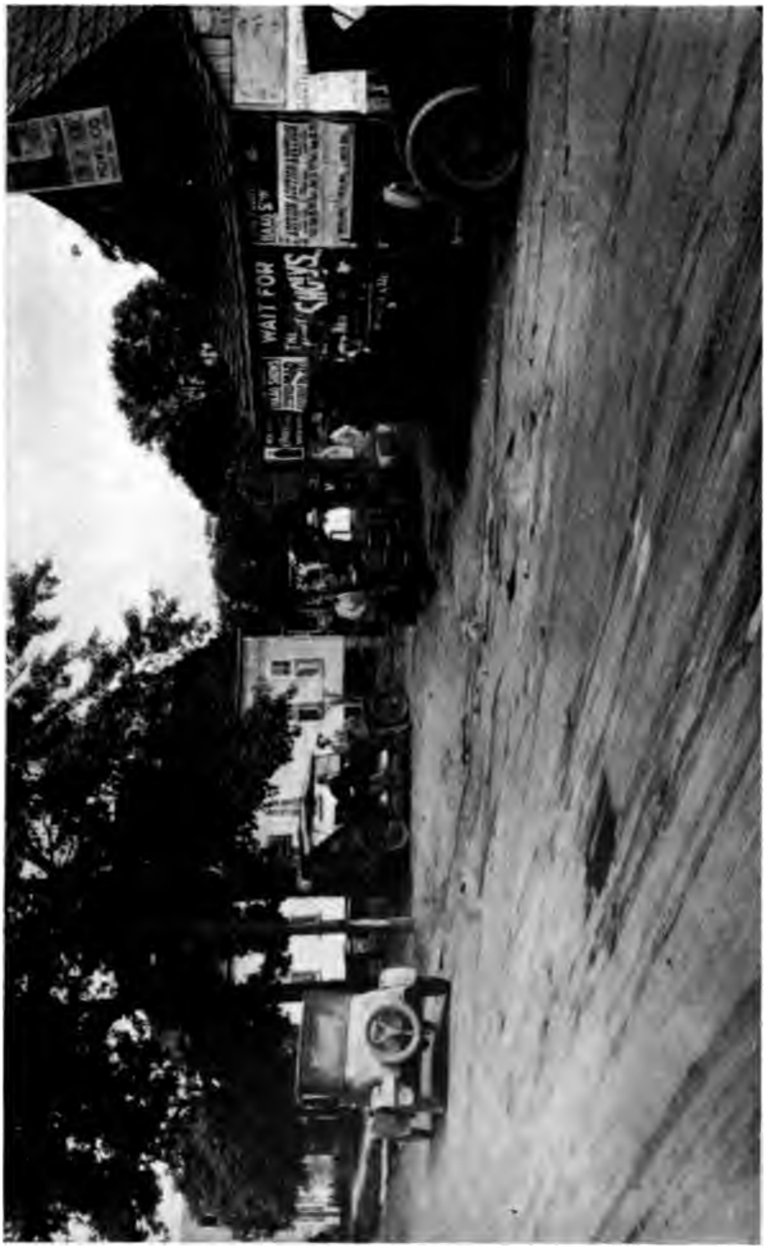


FIGURE 2. *Distillation curves.*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
3. Gasoline from Gurley, Madison Co. well. Sample by Williamson.
4. A commercial gasoline, fresh from storage tank.
5. Gasoline from Gurley, Madison Co. well. Sample by Grayson.

Dr. Robert S. Hodges, Analyst.

PLATE 3



No. 661. S. A. Barker's grist mill and well showing gasoline, and the McAllister well and residence.

Photo—Dr. Walter B. Jones, June 10, 1927.

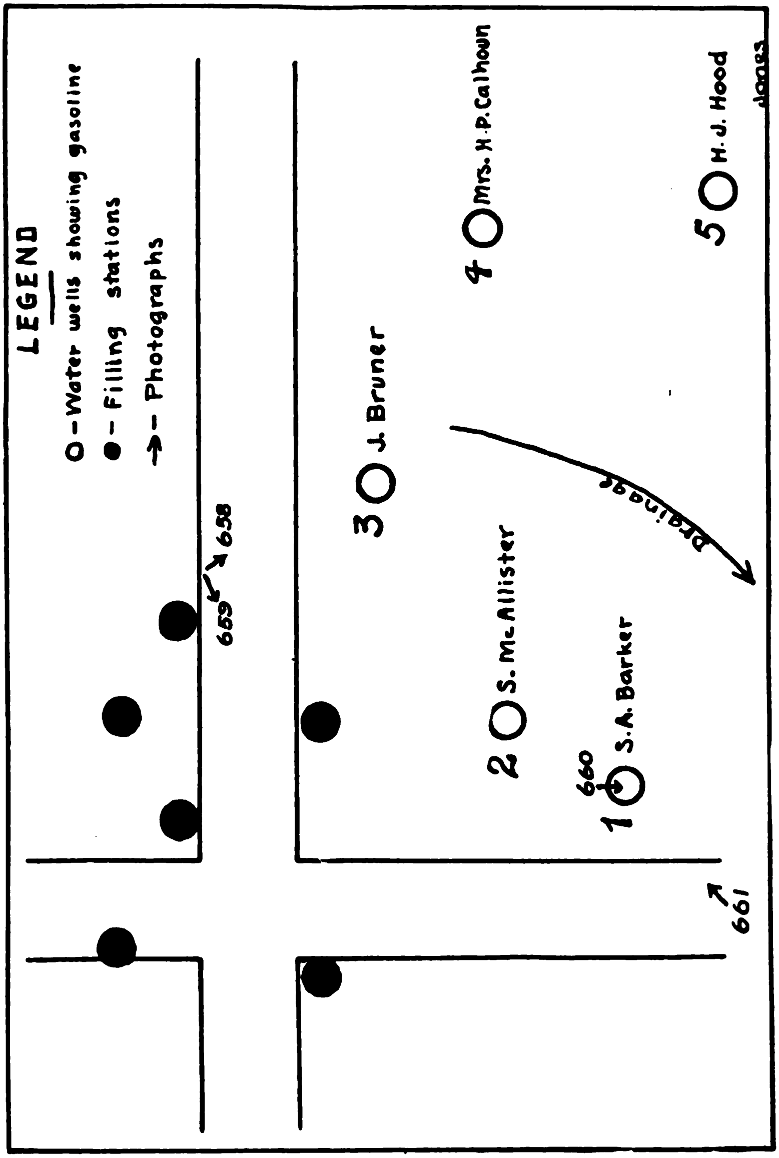


FIGURE 3. Sketch of Cottonwood, showing location of filling stations, and wells which have been polluted with gasoline. The locations are approximate only.

gasoline. The writer laid aside pressing duties and went to Cottonwood on June 9 and 10, to try to ascertain the facts in the case.

Upon the author's arrival in Cottonwood, a dozen sample jars were received through the kindness of Mr. S. O. Smith, for samples. Climbing down the pump line into Mr. Barker's well (see Plates 3 and 4) in spite of the fumes, a sample was secured. Although one could see an oil substance (see Plate 4) on top of the water, the film was so thin that not more than one-sixteenth of an inch shows on top of the water in the jar. Mr. Barker got a small amount from the drum. On the morning of June 10, Mr. Barker had his pump running, and there were some three gallons in the barrel. This had the same properties as that taken from the barrel on the previous afternoon, and showed signs of weathering. In perfect frankness, the writer believes that the material measured represents at least three days accumulation, with the exception of what had been given away. It would be difficult to determine the amount of liquid which comes into the well daily, but it is thought that it would not exceed three or four quarts. There was hardly more than eight ounces on the well the afternoon before, and the figure of three or four quarts daily is believed to be just about the truth. However, the exact amount which the wells make has nothing to do with the source of the material.

On the next morning, the McAllister well was drawn off, and a film of the material obtained, which was not more than half an ounce, and this too little to test. Johnnie Bruner drew off his well, and Mr. Barker siphoned off the water, getting about a half pint of gasoline. This material was considerably weathered and it was said that the well had not been drawn off for weeks. The curve of the distillation of the Bruner sample was more like a mixture of kerosene and gasoline, and was much more thoroughly weathered than the Barker sample.

Samples could not be obtained from the Calhoun and Hood wells, and it is understood that there are others which came in later. However, these will not change the situation in the least, but only serve to accentuate the greatest extent of the pollution.

Source. The source of the material is undoubtedly from leaks in gasoline tanks in the vicinity. Some one has been losing gasoline, and the loss has been rather considerable. Mr. S. O.

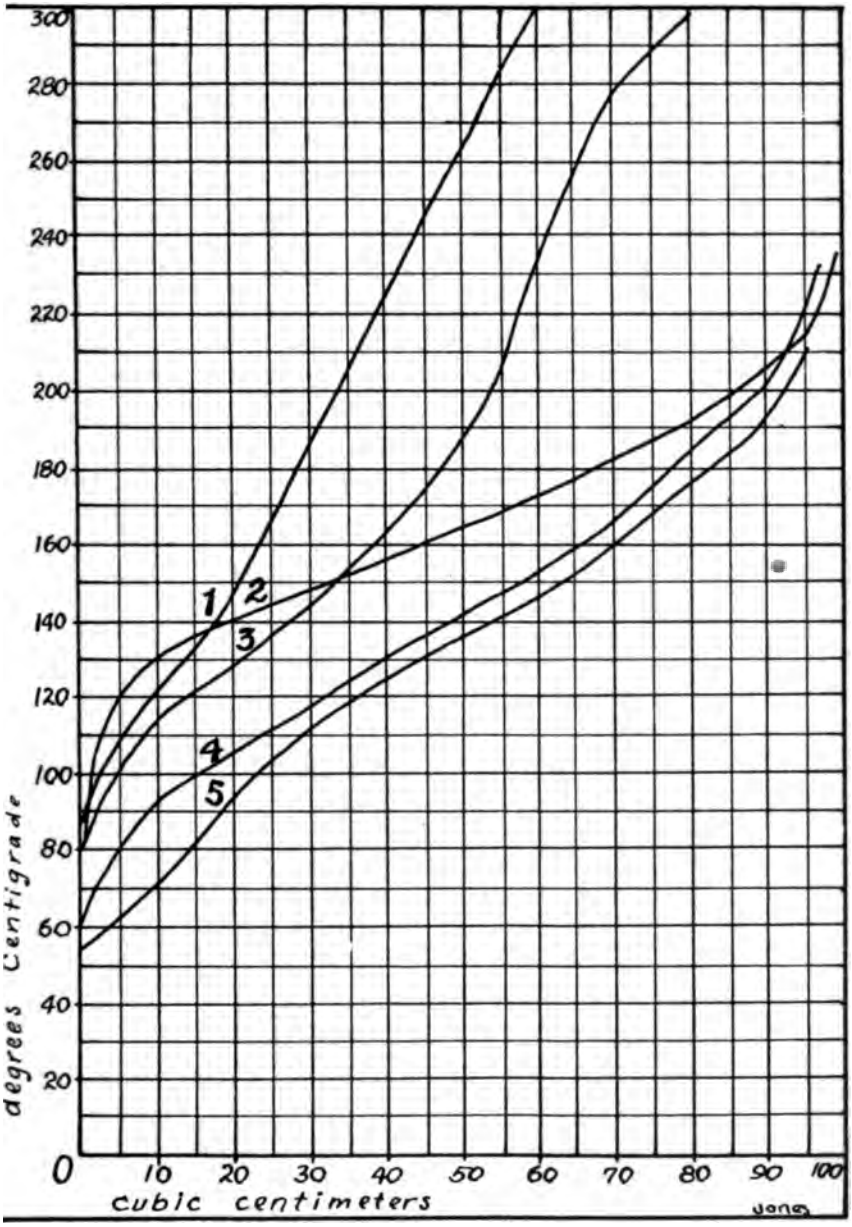


FIGURE 4. *Distillation curves*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Gasoline from S. A. Barker well, Cottonwood, Houston Co.
3. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
4. Gasoline from McAllister well, Cottonwood.
5. A commercial gasoline, fresh from storage tank.

Dr. Robert S. Hodges, Analyst.

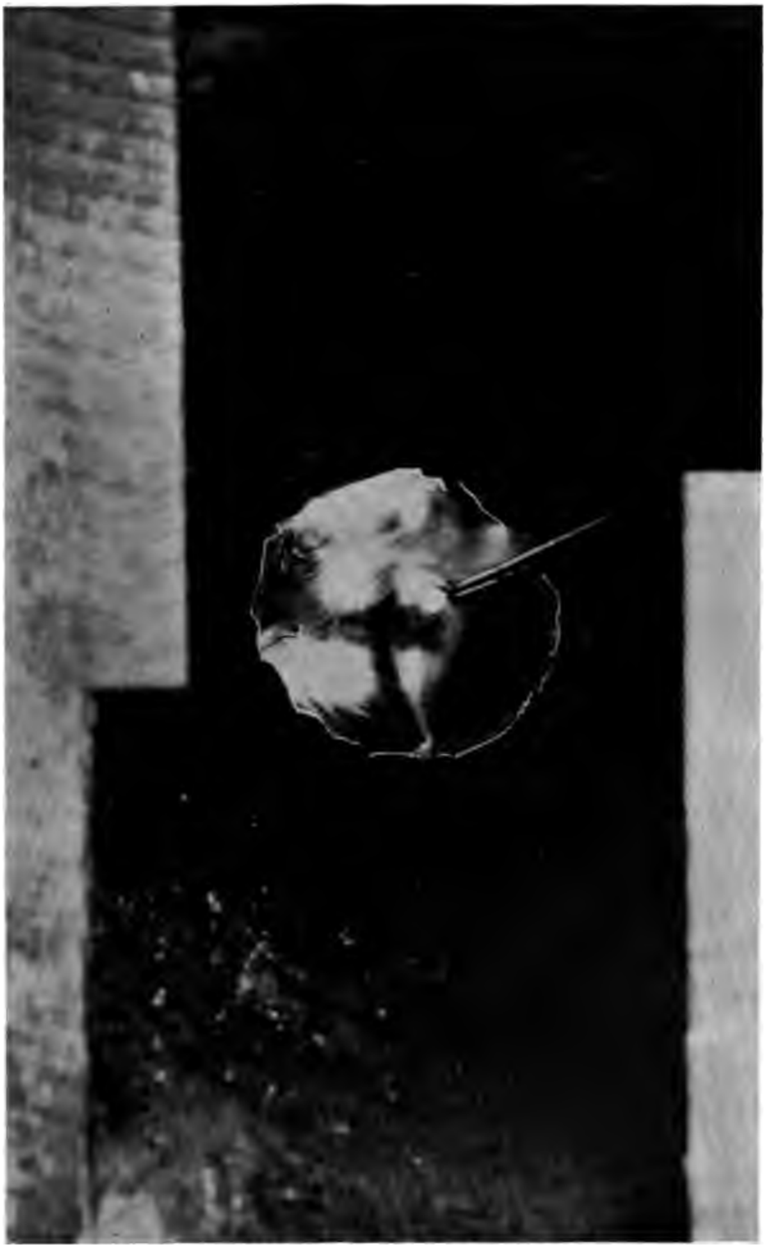
Smith stated that he could not say whether he had been losing gasoline or not. He has not kept a check on the amount received from the trucks and subsequently delivered to the cars. Even if the wells are not making more than three or four quarts a day it means that a large quantity of the material has escaped. It is quite easy to picture a leak, and the gasoline quickly diffusing into the porous sandy clay, which makes up the surface at Cottonwood. Naturally the material would follow along the water channels with the water supply, and into the wells. The complete passage from any of the filling stations to the Barker well would not require more than a few weeks. It would not be at all surprising if the tank or tanks responsible for the pollution were leaking at the present time.

After getting into the ground, all of the stuff would remain above the plastic, impervious clay, which makes up the subsoil throughout the section. That is one reason why the material invariably enters at the bottom, and along with the water supply. Each well ends at the top of this clay, for that is the source of the water in the area.

All of the wells in question have been dug many years. Even if the material were crude oil, it is unlikely that it would suddenly appear in a well which had been dug for such a long time. A statement of Dr. I. C. White, State Geologist of West Virginia and the father of petroleum geology, contained in a recent letter, with his permission, is reproduced in part below:

> "You are undoubtedly correct in your conclusion that the water pollution mentioned is due to a leak from gasoline or oil tanks. I have known many such occurrences when the source was many hundred feet distant, the polluting oil or gasoline appearing to pass along fissures in the stratified rocks until finding an exit into wells. A case of this kind has recently occurred in Pennsylvania where oil had been reported in a well a long distance, several miles, from any pipe line and it undoubtedly got into the well from a leaking pipe of the region. Where oil or gasoline suddenly appears in wells it may be set down as absolutely certain that the source is not from a natural reservoir like the earth strata but from some artificial source either near oı far distant."

PLATE 4



No. 660. Looking into Barker's well, showing pump line, and streams of water carrying a film of gasoline, entering the bottom of the well.

Photo—Dr. Walter B. Jones, June 10, 1927.

CHEMISTRY

Petroleum is a very complex substance containing essentially hydrogen and carbon, with various impurities like sulphur, nitrogen and the like. There is a wide range in specific gravity, color, odor, and viscosity. Some of the Mexican crudes are black and do not flow well through the pipe lines without heating. Other crudes are wine-colored or yellowish and might be about the same gravity as gasoline or even higher. Usually natural gas composed of hydrocarbons in a gaseous state is associated with crude petroleum. Natural gas is used frequently from the casing-head for the manufacture of gasoline and for blending with low grade gasolines.

The composition of petroleum cannot be gone into fully in this paper. Practically, the things which are of the greatest importance are the motor fuels and lubricating oils, obtained from refining crude petroleum. During refining there is produced, among other things, napthas, benzine, gasoline, kerosene, various grades of lubricants, heavy engine oil, cup grease, and finally a residuum of asphaltum or paraffin. Since the principal market among the lighter products is for gasoline, every effort is made to produce the very maximum amount of that substance. Naptha, benzine or even the by-product of coal, benzol are mixed with low-grade gasolines to bring them up to standard. In addition to this, the crudes are subjected to various processes of "cracking" to partially break up the heavier components into materials which can be employed for motor fuels.

The term gasoline is used in this report to mean "any mixture of light hydrocarbons intended for use in any kind of vaporizer." Gasoline usually has a gravity of 60 to 75 degrees Baumé, when marketed for use in auto engines. Kerosene usually ranges in gravity from 44 degrees to 49 degrees Baumé. Most of the material between 49 degrees and 60 degrees Baumé is used for blending with lighter material for gasoline.

The apparatus used in our laboratory for analysis of samples is very simple, consisting of a retort and condensing tube, the latter having a water jacket to facilitate condensation. A thermometer is placed in the open end of the retort and sealed. Heat is applied to the liquid, and the first drop going over into the

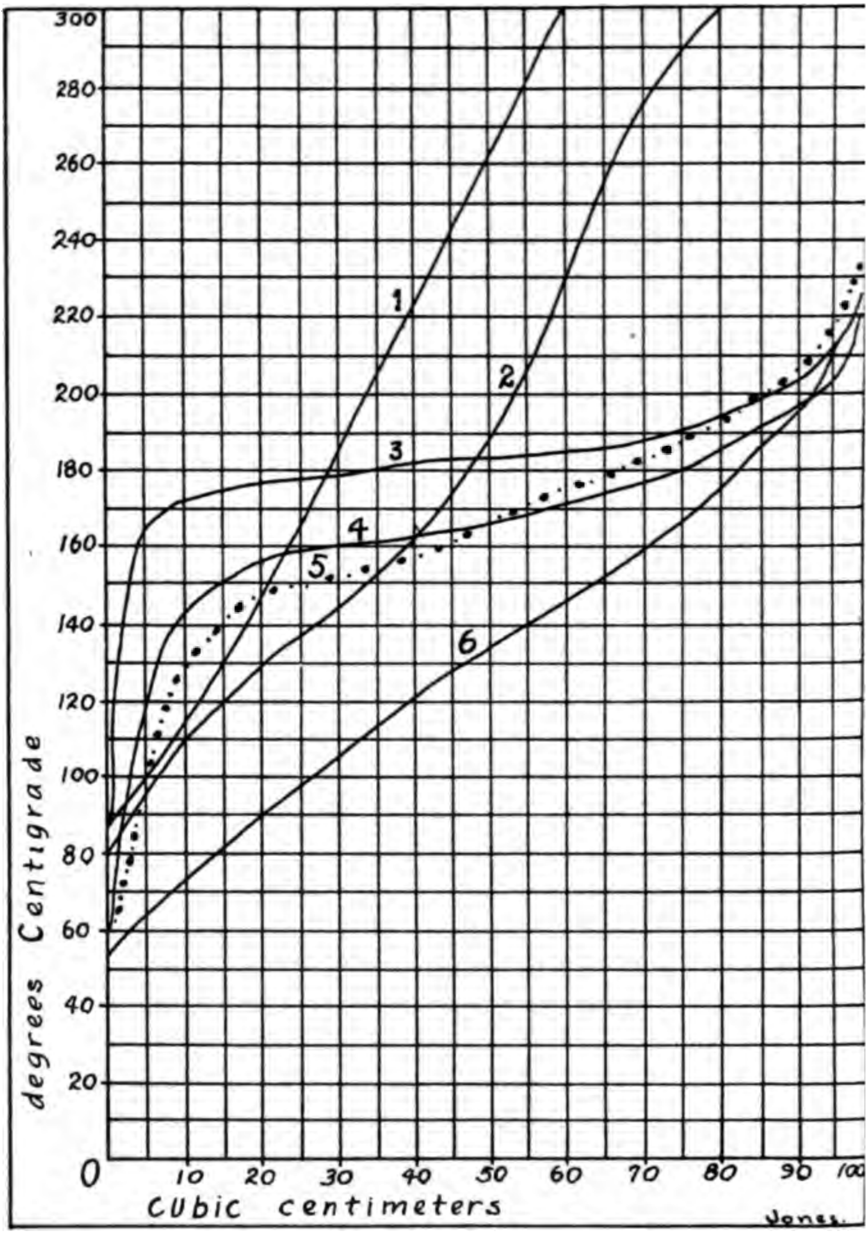


FIGURE 5. *Distillation curves*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
3. A commercial gasoline, allowed to evaporate for 5 days.
4. Ditto, after 3 days evaporation in air.
5. Gasoline from Barker well, Cottonwood, Houston Co.

6A. Commercial gasoline, fresh from storage tank.

Dr. Robert S. Hodges, Analyst.

condenser is regarded as the boiling point of the liquid. The maximum evaporation and condensation under atmospheric pressure takes place within the range of 300 degrees Centigrade. Any liquid which might remain at that point has to be further distilled in a vacuum. This part of the analysis is not carried out in our work.

In the examination of the samples, there are a few important factors in the determination of the identity of the product. For instance, if the distillation curve shows 90 to 95 per cent going over at or before 200 degrees Centigrade, it is quite likely that the material is gasoline, or if the curve shows most of the liquid evaporated by 300 degrees, it is likely to be kerosene. On the other hand, if 20 to 80 per cent goes over by 300 degrees, the material could be regarded as a mixture of lighter or heavier hydrocarbons, and might be crude oil. In a word, crude petroleum is a complex mixture of hydrocarbons of various gravities, and accordingly has a wide range in its distillation curve, while all of the refined products, even in mixtures, invariably show limited ranges.

Thus, it would hardly be possible for the laboratory technician to fail to determine accurately whether or not any sample was crude or refined. This point the writer wishes to emphasize, in order that those who would go to the trouble of questioning the results, might be prepared to present facts and not someone's guess or opinion.

Distillation Curves. In figures 1, 2, 4 and 5, are presented distillation curves of selected crude oils from Pennsylvania and Mexico, and gasoline samples from the various occurrences under discussion. For comparison, the same crude oil curves are used in each case. The commercial gasolines were selected at random, and distilled under precisely the same conditions and in the same apparatus as the various samples which were sent to the office, or collected by members of our staff, from Cottonwood and the other places. Since we are not advertising gasolines, we have withheld the names of the brands used. These will be supplied upon request.

In figure 1, there is a remarkable resemblance between the curves for commercial gasoline, and the samples sent us from Pine Hill and Pell City. Only one sample, No. 3 from Pell City, showed even the slightest effect of weathering or evaporation.

The other samples were undoubtedly pure gasoline, and unquestionably refined. The last 20 per cent of No. 4 Pine Hill and No. 6 Pell City showed identically the same curve.

In figure 2, there are some interesting conclusions to be drawn. It will be noticed that No. 5 from Gurley has a lower initial boiling point and curve up to 50 cc. This sample evidently is a high test gasoline, or gasoline blended with some such substance as benzol, several kinds of which are on the market at the present time. No. 4 in this figure represents fresh commercial gasoline, and No. 3 another Gurley sample. This last named curve suggests that the material had been evaporating for several days before it was collected. The end points of all these samples are practically the same.

In figure 4, the curves are somewhat different. Commercial gasoline is represented by No. 5, while No. 4 was given the writer by a citizen of Cottonwood, and was said to have come from the McAllister well. It will be remembered that the sample secured by the writer from that well was too small to test. The McAllister well sample is practically pure, only a small amount of the most volatile components having been removed by evaporation. On the other hand, the sample from the Barker well showed signs of considerable evaporation. Again, the end points are essentially the same. The sample of commercial gasoline showed nearly 4 cc. lubricating oil, and was unusual in that respect. Nearly all gasolines leave a residue of 1 to 2.5 cc. at 300 degrees Centigrade, but 4 cc. is unusual. It might be mentioned here that the largest residue recorded from any of the samples from Pell City, Pine Hill, Gurley or Cottonwood was 2.5 cc.

An effort was made to produce some results which could be more easily explained to the layman or non-technically trained person. At the author's suggestion, Dr. Hodges purchased 5 gallons of commercial gasoline, mixed the whole amount with water and clay, in a container which was left open at the top. After mixing, a sample was distilled. This is the No. 6 curve. The mixture was stirred, at intervals, to increase the thoroughness of evaporation. After three days, the lighter components escaped as is shown in No. 4 curve. After five days, only a few hundred cubic centimeters of the original five gallons remained. A sample of this residue was distilled, and the results presented in No. 3 curve. In comparison with these, a sample from the Barker well was distilled and is shown in No. 5 curve. This is the basis for the writer's suggestion that the Barker samples were at least three days old. It is quite likely that they may be older than that, for evaporation would not be so active in the bottom of a well, as it would in a window in a laboratory, in an open vessel. Another point of interest is that the samples evaporated in the laboratory invariably turn yellow, upon exposure, which is the color of nearly all of the samples from the localities under discussion. It might be said also that any sample which does not show a yellow or pale lemon color, is quite pure gasoline.

From the curves in figure 5, it is easy to see that the gasoline loses its lighter components, and the residue represents the heavier, less volatile fractions. The results of this experiment can be applied directly to any of the other samples. It was explained that most gasoline was composed of light hydrocarbons ranging in gravity from 60 to 75 degrees Baumé. The components at the 75 end would evaporate first, of course. Smaller portions of the others would go off also, but the change of the fluid from a mixture of 60 to 75 would gradually develop into a preponderance of heavier components at the 60 end. A distillation curve of the final 100 cubic centimeters residue from the evaporation of 50 or 10 gallons would be almost a straight line from 5 to 90 cc., and in addition to this, the temperature would remain between 180 and 200 degrees Centigrade, or near the upper end of range of heat needed to carry out the evaporation for gasoline. This is clearly shown in figure 5, curve No. 3.

The details of the distillation tests are presented in the following tables:

Cubic Centimeters	No. 1	2	3	4	5	6	7	8	9	10
	Degrees Centigrade									
0	80	55	60	60	80	55	80	120	60	80
5	165	65	......	......	......	......	120	......	......	......
10	172	72	145	130	130	70	130	150	95	137
20	177	90	156	141	140	95	140	155	105	154
30	178	107	158	151	150	110	150	160	117	164
40	181	122	163	159	159	125	159	164	130	180
50	184	135	166	167	166	135	166	168	142	186
60	186	145	171	176	174	145	174	174	152	200
70	189	160	177	184	......	160	......	178	165	210
80	195	175	185	194	193	175	193	185	185	227
90	203	195	194	206	205	190	205	195	200	255
95	210	210	202	217	217	210	217	206	217	290
99	225	......	220	232	......	......	235	210	230	300
Gravity Deg. Bé.	44.6	59.4	47.7	48.8	......	......	......	......	......	46.6

No. 1. Commercial gasoline, No. 1 brand, after 5 days evaporation.
" 2. Commercial gasoline, No. 1 brand, fresh.
" 3. Commercial gasoline, No. 1 brand, after 3 days evaporation.
" 4. Gasoline samples from Cottonwood, No. 1 A., Barker well, July 7.
" 5. Gasoline sample from Cottonwood, No. 1 A., Barker well, July 16.
" 6. Commercial gasoline, No. 1 brand.
" 7. Gasoline sample from Cottonwood, No. 1, Barker well.
" 8. Commercial gasoline, No. 1 brand, evaporated to one-half its original volume.
" 9. Gasoline sample from Cottonwood, McAllister well.
" 10. Gasoline sample from Cottonwood, Bruner well.

Cubic Centimeters	No. 11	12	13	14	15	16	17	18	19
	Degrees Centigrade								
0	160	80	75	75	50	60	......	......	80
5	......	......	110	......	65	......	......	90	150
10	195	115	125	......	80	90	80	......	165
20	202	127	135	115	105	110	100	104	170
30	207	145	140	......	120	124	110	110	175
40	215	160	145	130	130	134	120	124	180
50	220	185	155	......	142	144	132	138	185
60	226	230	160	150	156	154	143	154	190
70	233	275	170	160	164	170	160	176	195
80	240	300	180	175	175	180	180	200	205
90	253	......	200	195	188	204	205	224	215
95	265	......	220	......	200	220	220	......	230
99	276	......	230	210	210	232	......	240	235
Gravity Deg. Bé.	......	46.6	52.3	......	......	56.0	......	......	49.0

No. 11. Commercial kerosene.
" 12. Crude petroleum from San Pedro, Mexico.
" 13. Gasoline sample from Gurley, by Mercer Williamson.
" 14. Gasoline sample from Gurley, by D. A. Grayson.
" 15. Commercial gasoline, No. 2 brand.
" 16. Gasoline sample from Pine Hill.
" 17. Gasoline sample from Pell City, No. 1.
" 18. Gasoline sample from Pell City, No. 2.
" 19. Gasoline sample from Cottonwood, Barker well.
Sent by Mr. Herman Gunter.

Conclusion. At first glance, it seems ridiculous that such occurrences as those discussed in this paper should require a second thought. Occurrences of gasoline have never been known in nature. The nearest approach was some external light crude in West Virginia, with a gravity of 67 degrees Baumé. This crude had all the characteristics of crude petroleum, however, and was limited in quantity. On the other hand, occurrences of gasoline in shallow wells have been reported from all over the United States, in rocks representing every age from earliest or Pre-Cambrian to recent sands at the seashore. It has been the experience of those working with crude petroleum and its refined products, that it is not at all difficult to differentiate between the mother liquid and its products, even in mixtures. The cases in Alabama have been very easy to determine, and thus little time was spent in explanation.

It is hoped that the data presented in this paper will serve to set at rest all unbiased minds. Those who still question the conclusions reached by us are urged to send samples to any reputable chemist for analysis.

The writer wishes to again state that this circular was not prepared to discount the chances of finding oil or gas in Alabama, but to set at rest for all time, the rumor that occurrences of gasoline in shallow wells are signals to drill for oil at those points.

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GEOLOGICAL SURVEY OF ALABAMA

EUGENE ALLEN SMITH, *State Geologist*

CIRCULAR NO. 3

CONCERNING OIL AND GAS IN ALABAMA

By
EUGENE A. SMITH

UNIVERSITY, ALABAMA
1917

BROWN PRINTING CO. MONTGOMERY.

CONCERNING OIL AND GAS

THE striking of a small pool of oil in a deep well at Cordova in December, 1916, has aroused such an interest in the oil and gas possibilities and probabilities of the State that it has been thought desirable to bring together and publish a few notes concerning the occurrence of oil and gas in general, and to review what is known and what may reasonably be inferred concerning their occurrence in Alabama in particular.

I.

ORIGIN AND DISTRIBUTION OF OIL AND GAS.

The theories concerning the origin of oil and gas are the inorganic and the organic, or combinations of the two.

The *inorganic* theory accounts for the formation of oil and gas by chemical reactions which take place without the aid of living organisms. The organic theory assumes that the chemical reactions, resulting in the formation of oil and gas, take place in connection with the decomposition of some forms of organic matter, vegetable or animal. The *organic* theory seems to be the one most generally accepted, but it is admitted that the precise reactions by which organic matters are converted into oil and gas are not definitely known in every detail. In whatever way produced, experience has shown that the strata in many parts of the world are more or less filled with oil and gas. The porous, open grained strata, like sands, sandstones, conglomerates, dolomite rocks, hold much more of these products than close grained shales, clays and limestones. Through the porous rocks oil, gas and water circulate slowly under the influence of gravity and other forces. If the porous rocks or sands are oil-saturated merely, it is not necessarily the case that there will be accumulations of economic value, for there are some other vital points in applied geology as related to petroleum. These have been summarized by Dorsey Hager in his book, "Practical Oil Geology," as follows:

> "1. Commercial oil and gas deposits occur in the higher parts of folds or wrinkles of the earth's surface called anticlines, domes, monoclines, etc.
>
> 2. Water is always found in the same stratum as the oil, but in the lower part of the fold.
>
> 3. All commercial deposits so far, have occurred in sedimentary or water-laid deposits such as sands, sandstones, conglomerates, shales, and limestones.
>
> 4. All oil and gas deposits, so far as known, are capped or covered by practically impervious beds of shale, sandstone, limestone; also such deposits are underlaid by impervious beds."

The impervious beds above and below the oil sands prevent the indefinite diffusion of the oil and gas. If the sands holding these are horizontal, the water will be found at the bottom of the sand, the oil and gas above it in the order of their relative weights or densities; but in such flat sands the oil will not be found in paying quantity, since it will occupy only a portion of the thickness of the sands; but it may occupy the whole thickness of the sands and thus be in such quantity as will pay for extraction where the strata are bent upwards into folds or anticlinals, under which at the top of the fold, may be found, first the gas, then the oil, and below them both the water.

In the synclines or downward folds of the strata, water will be found normally occupying the bottoms of the basins, but where the sands are more or less dry, there may be an accumulation of oil in these synclines.

Minor folds along the flanks of a greater anticlinal or synclinal fold may produce secondary anticlines under which oil may accumulate, or in the secondary anticlines thus produced, one flank may be gently the other steeply inclined, and the gently inclined flank may be to all intents and purposes horizontal. Under such conditions terraces may be formed which are important oil reservoirs in many fields.

These relations are shown in the following figures in which the solid black represents the accumulation of oil, over which it may be assumed that there will be more or less of gas. Where the gas is specifically shown in a figure the space occupied by it is left white. The dotted portions of the diagrams represent the porous sands, which, below the oil may be considered as saturated with water, unless otherwise specified.

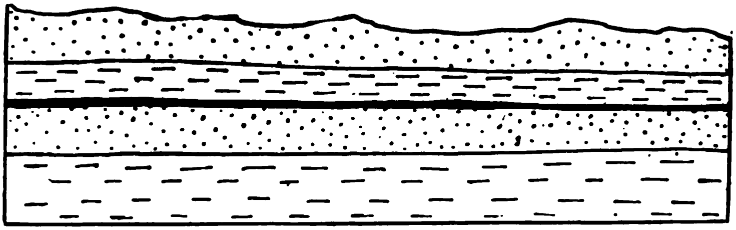


Fig. 1. Showing oil sands in horizontal position, unfavorable to the accumulation of oil in commercial quantity.

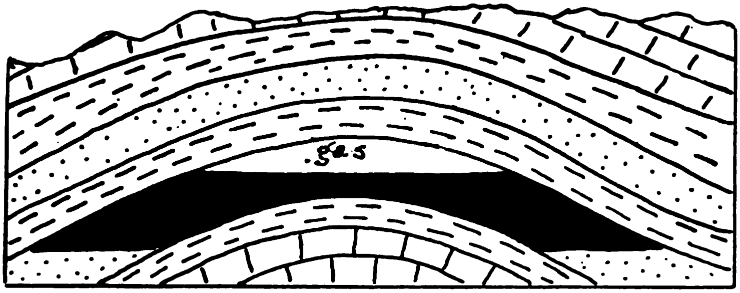


Fig. 2. Accumulation in commercial quantity of oil and gas under an anticlinal fold.

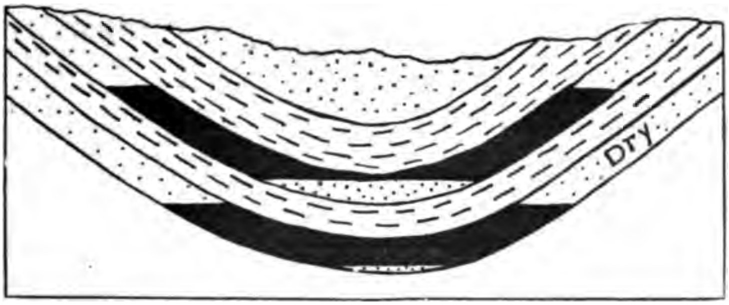


Fig. 3. Synclinal basin in which oil may be found if the porous sands are more or less dry.

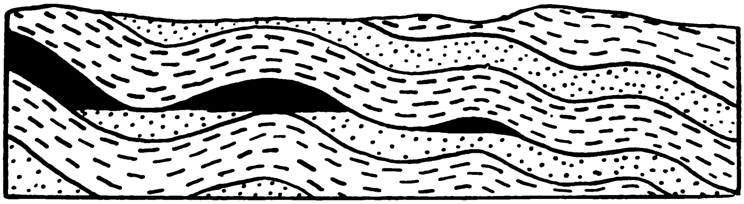


Fig. 4. Showing oil accumulation under minor folds developed along the flank of an anticlinal or synclinal.

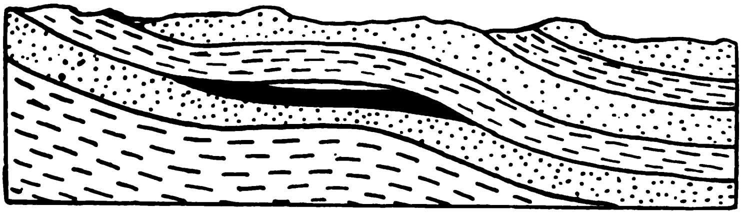


Fig. 5. Oil accumulation on a "terrace."

Oil sometimes accumulates in sand lenses in shale formations, in what are called oil pools illustrated in Figure 6 below.

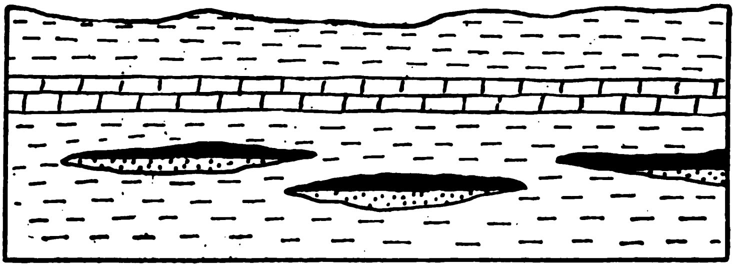


Fig. 6. Oil accumulation in sand lenses in a shale formation; "oil pools."

A divide between the water courses must not be confused with an anticline, which involves the bending up of the strata, while the strata in a divide produced by erosion, may be horizontal or of synclinal structure, in either case unfavorable for the accumulation and retention of oil, as a little consideration will show.

Following are a few statements from Hager's "Practical Oil Geology," which are worthy of consideration:

> "From experience it is known that folds of the strata are important in oil accumulation. Where the folds are exposed at the surface their existence at some depths may be inferred.
>
> 1. All folds do not carry oil.
>
> 2. A geologist cannot tell whether or not a fold will carry oil unless wells are already drilled in it.
>
> 3. He does know that the majority of folds within certain (proven) limits do carry oil, and that the chances are in favor of a well-defined fold being productive if it occurs within certain boundaries."

Regarding surface indications of oil Mr. Cunningham Craig in his book "Oil Finding," says:

> "Actual shows of oil are of great importance; much is to be learned from them, but the study of structure must take first place. As a matter of fact it is very frequently where surface shows of oil are seen that drilling would be entirely unsuccessful, and many of the greatest oil fields known today have not a single surface indication within their length and breadth."
>
> "Surface indications are of various kinds according to the class of oil, the nature of the strata, and the geological structure. They comprise:
> (a) Seepages of oil.
> (b) Asphalt deposits.
> (c) Evolution of gas from gas pools, mud volcanoes, or dry ground.
> (d) Outcrops of bituminous strata.
> (e) Veins of manjak or ozokerite.
>
> "In addition to these the evolution of hydrogen sulphide may be in some cases a favorable indication, and crystals of sulphur in cavities in a rock, or the presence of minute traces of sulphur in flecks and patches may also be important. * * * A faint odor of petroleum may sometimes be detected where no actual seepage can be discovered.
>
> "A stratum which is oil-bearing at one place may not be at another place, just as sediments of different kinds, sands, clays, and vegetable accumualtions are laid down simultaneously along a shore line; hence the impossibility of tracing any oil sand for any great distance."

SOME ALABAMA LOCALITIES WHERE THE GEOLOGICAL STRUCTURE SEEMS TO BE FAVORABLE FOR ACCUMULATION AND STORAGE OF OIL.

APPALACHIAN PROVINCE.

Cincinnati Anticline.

The great anticlinal arch of Ohio, the Cincinnati Anticlinal, extends southward through Kentucky and Tennessee into Alabama where its presence is recognized by the outcrops above drainage, of Silurian and Ordovician strata along Flint River in Madison, Limestone Creek and Elk River in Limestone, and Blue Water and Shoal creeks in Lauderdale near the Tennessee line. On this anticlinal and especially along its flanks occur in Ohio and West Virginia some of the most important gas and oil wells of the country. In Northern Alabama from Madison and Morgan counties westward the phenomena accompanying oil and gas are numerous. These are occurrences in all the counties included, of natural gas, tar springs, bituminous sandstones, bituminous limestones, and petroleum. Borings at Huntsville have yielded some gas which has been utilized to a limited extent in the city. In Morgan County in section 30, township 7, range 6-W. are the Goyer wells sunk many years ago in search of oil, of which a small amount was struck. The report of the Alabama Geological Survey on the Tennessee Valley Region by Henry McCalley, gives abundant details of all these occurrences.

Within the limits of the coal field in Marion, Franklin and Fayette counties there are also evidences of oil and gas at Atwood in Franklin, and Hamilton in Marion where the cores of diamond drill have brought up oil-saturated sands, and near Fayette Court House in the county of the same name are gas wells that have been active for a number of years and which have yielded gas in commercial quantity to the town of Fayette.

Bulletin No. 10 of the Geological Survey is devoted to this Fayette County gas region.

From the above it may be seen that this region of Alabama over the arch which represents the termination of the great

Cincinnati anticlinal, should by analogy be favorable for oil and gas prospecting.

Democrat Ridge.

The great Sequatchee—Blount Springs Valley, extending northeast and southwest from Alabama into Tennessee, is in the valley part, an eroded anticlinal. The unbroken anticlinal uplift beyond the northeastern end of the valley in Tennessee is the Crab Orchard Mountain, the corresponding extension of the valley in an uneroded uplift to the southwestward is known as Democrat Ridge. This well defined anticlinal uplift may be followed easily southwestward from Ried's Gap down through Jefferson, and probably into Tuscaloosa County. It is in part the boundary between Jefferson and Walker. Structurally this ridge and its prolongation to the southwest should be promising ground for oil prospecting. Several deep wells near Bryan on the Ridge and at Jasper and near Cordova along the western flank of the uplift, have proven the existence of oil, although as yet not in commercial quantity. A careful study of the geological structure along this uplift and its flanks might well be expected to show promising locations for deep wells.

Northwestern Limb of the Warrior Basin Syncline.

The wide synclinal basin of the Warrior Field, lying between the Democrat Ridge uplift and its prolongation to the southwest on the one side, and the escarpment of Sand Mountain and the termination of the Cincinnati uplift on the other side, is unsymmetrical in that the gentle slopes of the northwestern limb of the syncline cover most of the territory, the axis of the Basin being near its southeastern edge. Along this wide area of the northwestern limb of the synclinal it may be that minor folds are developed which afford conditions favorable for oil accumulation such as yield a great portion of the oil and gas of Pennsylvania and West Virginia. Fig. 4 above would illustrate such subordinate folds on a limb of a great synclinal.

The Appalachian Valleys.

In the great Coosa Valley Region, and in the outlying anticlinal valleys, Cahaba, Jones, Roups, Murphrees, Wills, and

Blount Springs, erosion has cut down into Ordovician and Cambrian strata in the central part, and the conditions therefore are in general not favorable for oil and gas accumulation.

Along the southeast flank of the Red Mountain bordering ridge of Jones Valley, and between that ridge and the Shades Mountain border of the Cahaba Coal Field, there is the wide valley of Shades Creek, exposing strata of the Subcarboniferous or Mississippian formation. This wide expanse of these rocks can be due only to a flattening of the strata, or a series of faults. In the first case if due to flattening, there would almost inevitably be minor folds produced, favorable to oil accumulation. Similarly, to the east of the Coosa Coal Field the wide area of Subcarboniferous rocks may be associated with analogous folds. Those interested in oil prospecting might consider these possibilities.

In the great Coosa Valley region the presence of strike faults and broken folds, would in general, be unfavorable for oil accumulation.

Oil Sands of the Appalachian Province.

The drillings which have brought up some notable shows of oil in this province, have struck these sands in the Pennsylvanian or Coal Measures and the other Paleozoic formations down to the Trenton of the Ordovician.

The Cordova well, which has yielded the largest show of oil finds it in the Coal Measures. It is too early yet to locate productive oil sands in the State.

COASTAL PLAIN PROVINCE.

The two formations which make this part of the State are the Cretaceous and the Tertiary.

CRETACEOUS.

The subdivisions of this formation named in ascending order are the Tuscaloosa, the Eutaw and the Selma Chalk.

The *Tuscaloosa* is made up of sands and clays of fresh water origin generally. Some of the strata are plant-bearing.

The *Eutaw* is composed of marine formations in the main, sands and clays, the sands partly calcareous and glauconitic.

The principal rock in the *Selma* formation is a chalk mostly with varying admixtures of clay. Above this chalky part the sandy strata of the *Ripley* are in evidence, especially in the eastern part of the State. The upper beds of the Cretaceous are generally sandy but they are generally classed with the chalk on account of the similarity of their fossils.

Where these beds of the Tuscaloosa and Ripley are of estuary origin they should be suitable for oil production.

Prairie Bluff.

At the Prairie Bluff ferry and landing and at Rock Bluff, a mile above the warehouse landing, we find a decided and relatively steep dip of some of the strata. Both at Prairie Bluff and at Rock Bluff, the strata at the top of the Bluff lie nearly horizontal, while those constituting the lower halves of these bluffs show the high angle of dip. Between the two series there is thus apparently an erosional unconformity, unless the high angle of dip of the lower strata is the result of cross bedding on a large scale. It might be worth while for oil prospectors to look more closely into this instance of a very sudden change in the angle of dip, as possibly affording the conditions favorable to the accumulation and storage of oil.

TERTIARY.

The formations making up the Tertiary of Alabama in ascending order are the Midway, the Chicasaw or Wilcox, the Buhrstone, the Claiborne and the St. Stephens, above which are the Grand Gulf beds as originally defined by Dr. Hilgard.

These contain estuarine deposits at many horizons, and with favorable structure conditions, there should be many oil sands in the formation.

Hatchetigbee and Jackson Anticlinals.

While engaged in the mapping of the Alabama Coastal Plain during the years 1883-87, the present writer and his Assistant, D. W. Langdon, located and mapped two well-defined anticlinals in the Tertiary terranes, viz., the Hatchetigbee and the Lower Peach Tree uplifts. At the same time at several points southward of Jackson in Clarke County unconformable contacts were noticed of Vicksburg and Jackson limestones with underlying formations showing some comparatively recent crustal movements in that section.

In 1905 this region was investigated for the Geological survey by Mr. S. A. Hobson, whose map of the Jackson Anticlinal is given in Fig. 8 below, along with his cross section Fig. 9 explanatory of the structure.

The map Fig. 7 copied from our Geological Map of 1894, but revised for the Jackson Anticlinal, will serve to show the locations of the anticlinals above named. The Hatchetigbee anticlinal may be traced from Bladon Springs nothwestward towards Shubuta in Mississippi, and southeastward into Clarke County, Alabama, towards Jackson, and southward of Jackson there is what appears to be a continuation of the anticlinal down as far as Oven Bluff on the Bigbee River. Along the southern flank of the Hatchetigbee anticlinal through Choctaw and Washington counties, there are many interesting occurrences of salt seeps and gas escapes. In Clarke County also along the Jackson anticlinal are similar phenomena. At several places in Clarke County as well as in Washington deep wells as well as shallow ones have afforded brine from which salt was extensively manufactured during the strenuous times of the Civil War. Almost anywhere along these anticlinals escapes of inflammable gas are numerous. Of late years several deep wells have been put down along the lines of these anticlinals without success so far as the bringing in of commercial quantity of oil is concerned, though in one instance at least there seems to be no doubt that a small quantity of oil was struck. These anticlinals, none the less, seem to be most promising localities for future tests for oil, and it is altogether probable that a closer study of the structure than has yet been given to this area, may point out the places where test wells should be sunk with the best chances for finding oil. It is doubtful if any of the deep wells up to the present time have been located with special reference to the details of geological structure.

The accompanying map and cross section of the Jackson anticline are here given as representing the present interpretation of structure and distribution of the formations involved. Further investigations by this Survey now in progress may modify in some respects the views expressed below.

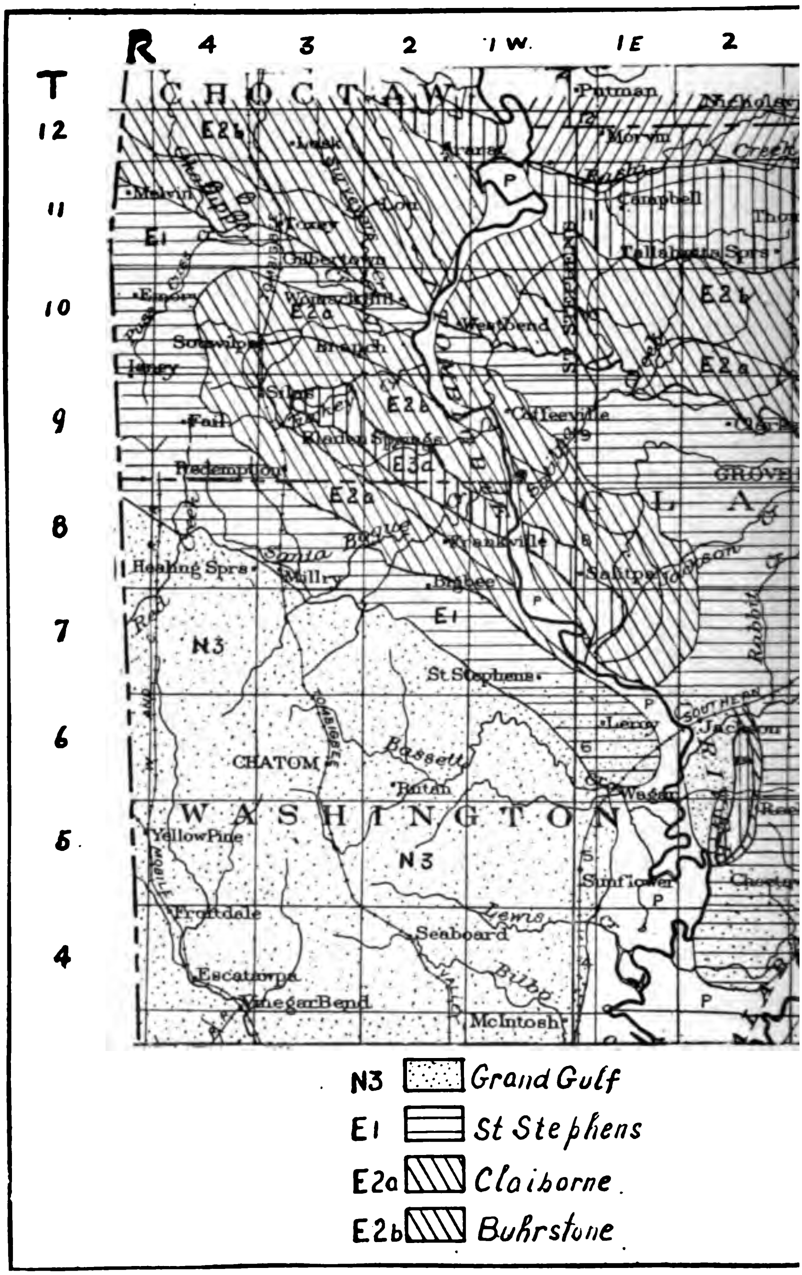
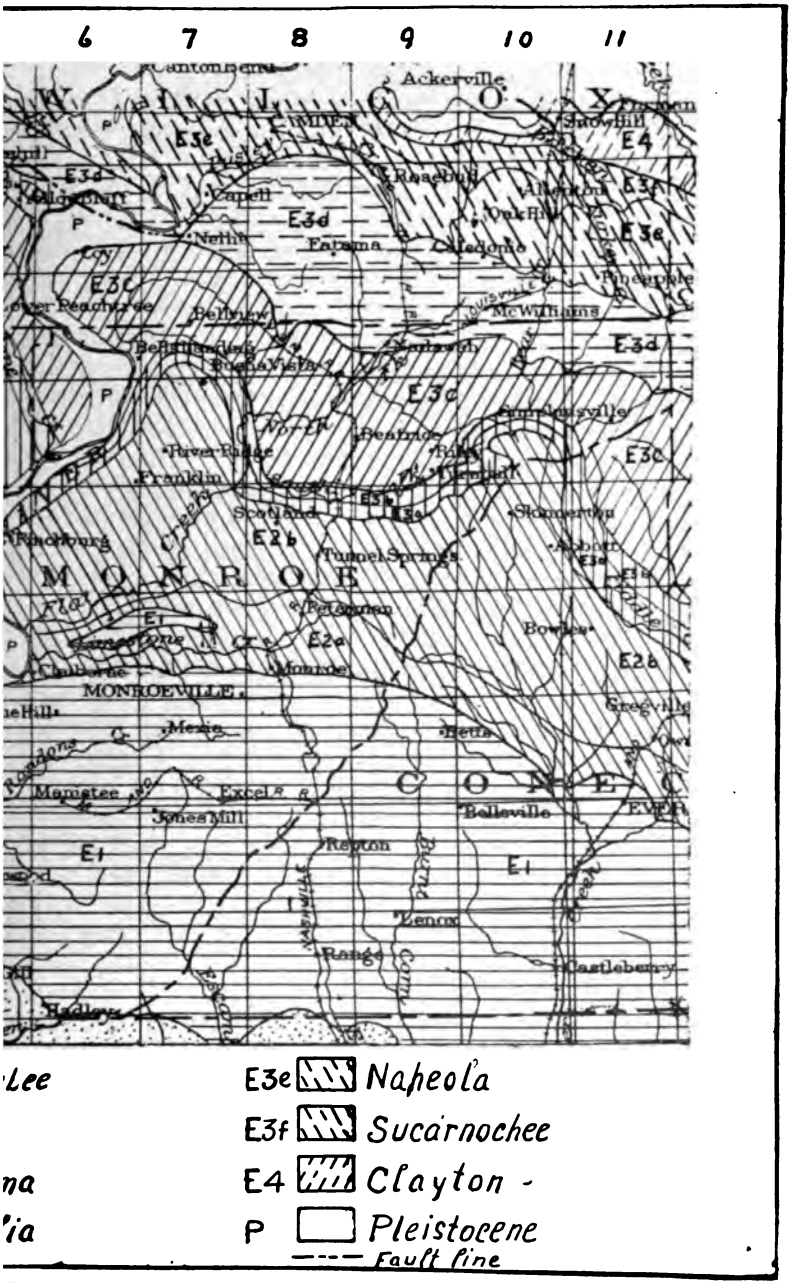


Fig. 7. Geological map of part of Alabama, including the H
geological map of 1894, with the add



Lower Peach Tree anticlinals. Copied from the author's the Jackson anticlinal made in 1905.

Some of the peculiarities in the Jackson anticlinal may here be mentioned in connection with the explanation offered by Mr. Hobson: The Orbitoidal limestone of undoubted Vicksburg age may be seen in places resting directly upon the clays and sands of the Hatchetigbee, while in other places not far distant, this limestone rests upon the thin remnant of Buhrstone which there shows between the Hatchetigbee and the Vicksburg. In other places it is the Jackson limestone which is directly upon the Hatchetigbee. The two sides of the anticlinal, so far at least as the strata are exposed, show marked differences. On the east this succession is usually more complete, especially towards the northern end of the anticlinal. Towards the lower end, however, the irregularities in the way of missing or thinned down formations are more in evidence. On the western side, on the other hand, none of the strata involved are seen except the Vicksburg limestone, which in the most westerly exposure, rests upon the Hatchetigbee, which is the lowest of the formations involved in the uplift. A possible explanation of this is that the crest of the anticlinal lies to the west of any of the exposures of the Tertiary rocks where it is hidden by more recent formations, or possibly in addition to this, the erosion of the valley of the river may have removed much material, and thus lowered the level of the Tertiary rocks below the reach of observation. It is very probable that some of the unconformities are due to faults.

Many of the phenomena of this anticlinal we cannot clearly explain, but it seems evident, as Mr. Hobson has suggested, that after the deposition of the lower Tertiary formations, up to and including the upper Claiborne, came the wrinkling of the strata into the anticlinal fold, then the denudation of its crest down to the Hatchetigbee clays. In this erosion the next overlying Buhrstone and Claiborne were thinned down to sharp edges towards the center of the anticlinal.* Then came a depression and a transgression of the Jackson and Vicksburg seas continuing through both periods, and allowing unconformable deposition of the characteristic limestones of these

---

*In going from the Lower Salt Works up the old road to Cherry, one crosses successively the outcrops of Buhrstone, Claiborne and Jackson to the Vicksburg. The Buhrstone here shows a thickness of only 75 feet, the Claiborne, by only 3 or 4 feet, the Jackson and Vicksburg show normally to all appearance.

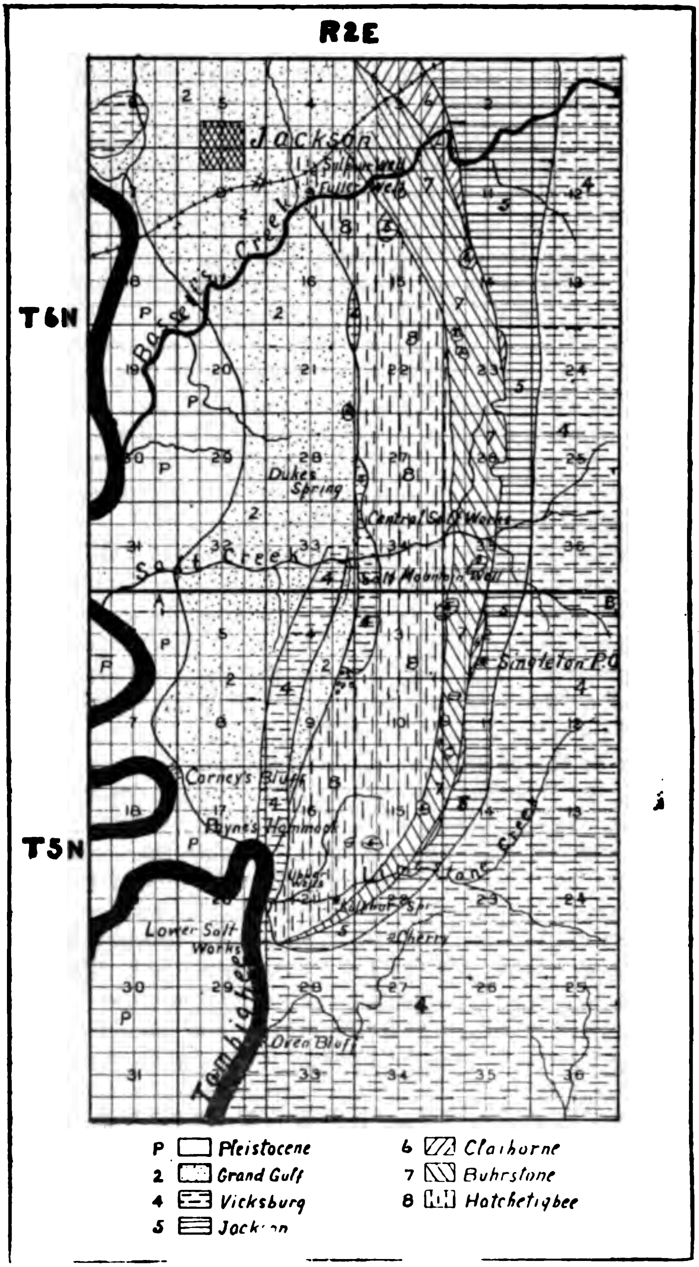


Fig. 8. Map of the Jackson anticlinal by S. A. Hobson, 1905.

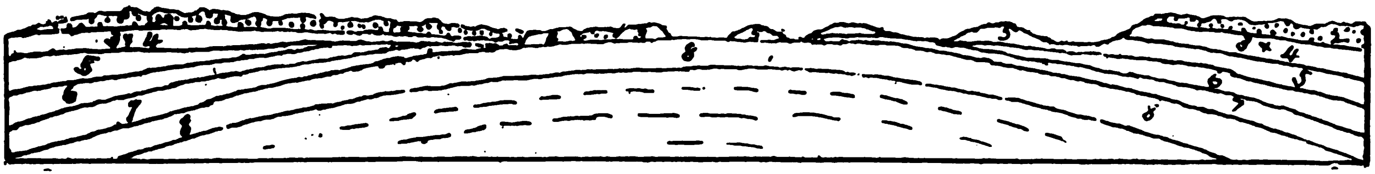


Fig. 9. Cross section of the Jackson anticlinal along the line A-B near the Central Salt Works, showing the thinning down of the Buhrstone and Claiborne beds toward the center of the uplift, and the unconformable contact of the Jackson and Vicksburg strata with the Hatchetigbee and Buhrstone. 2. Grand Gulf. 3 and 4. Vicksburg. 5. Jackson. 6. Claiborne. 7. Buhrstone. 8. Hatchetigbee.

surface indication within their length and breadth." With reference to the claim made in some of the advertisements, of the existence of volcanic cinders, gas blowouts, etc., as certain indications of the presence of oil, I may say that there is certainly no evidence of any volcanic activity in Mobile County, but even if there were it would be against the probabilities for oil-finding, since all commercial bodies of oil occur in sedimentary or water laid deposits. Still less do I have any faith in the location of oil pools, or of any mineral deposit, by means of a mineral rod, or divining rod, or by whatever name it may be called.

EUGENE A. SMITH,
State Geologist.

University of Alabama,
June 27, 1917.

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GEOLOGICAL SURVEY OF ALABAMA
EUGENE ALLEN SMITH, State Geologist

CIRCULAR 4

PETROLEUM PRODUCTS IN SHALLOW WELLS IN ALABAMA

BY
WALTER B. JONES, PH.D.
ASST. STATE GEOLOGIST

UNIVERSITY, ALABAMA
JULY, 1927

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BIRMINGHAM PRINTING COMPANY
BPCo
PUBLISHERS

LETTER OF TRANSMITTAL

University, Ala., July, 1927.

Hon. Bibb Graves,
Governor of Alabama,
Montgomery, Alabama.

Sir: I have the honor to transmit herewith the manuscript of a report on the Occurrences of Petroleum Products in Shallow Wells in Alabama, with the request that it be printed as Circular No. 4 of the Geological Survey of Alabama.

Very respectfully,

Eugene A. Smith,
State Geologist.

GEOLOGICAL SURVEY CORPS

Eugene Allen Smith, Ph.D.	*State Geologist*
Walter Bryan Jones, Ph.D.	*Assistant State Geologist*
Stewart J. Lloyd, Ph.D	*Geologist*
Robert S. Hodges, D.Sc.	*Chemist*
Roland M. Harper, Ph.D.	*Geographer*
Harry E. Wheeler	*Curator of the Museum*
Mrs. Herbert H. Smith	*Assistant Curator of the Museum*
Elizabeth Jennings	*Secretary*

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INTRODUCTION

SINCE the occurrences of petroleum products in shallow wells have become quite common in recent years, it has been thought advisable to investigate the most recent of the occurrences and make a complete report concerning the facts, as nearly as they can be determined. Fortunately, the Survey has samples from all of the areas reporting these materials, and considerable work has already been done.

The writer wishes to state in the beginning that it is his sworn duty to present to the general public specific facts, without evasion or reservation. This department has been in continuous operation since 1848, and its aim has always been to present more to the prospective investor and operator, than he was led to expect. Often it is not possible to determine accurately the possibilities of any particular ore deposit, but in cases such as the occurrences of gasoline, there can be but one answer. This department has a dual rôle to play. On the one hand, projects which appear to lend themselves to remunerative exploitation are boosted. On the other hand, those which cannot be turned into a modest return or chance for return, on the investment, are summarily dismissed or relegated to the uncertain columns. So far as the main question is concerned, this department is dismissing forever this gasoline affair and all like affairs which may come up in the future.

Gasolines have a pungent odor, while most crude petroleums have a not unpleasant odor, if any at all. This same thing applies to all refined products which have sufficient lighter components to volatilize. Another valuable point is that gasoline has never been found in nature. The nearest thing to it was an occurrence in West Virginia* where an extremely light crude oil was produced. This crude came from the Otto No. 1 Well, 3 miles northeast of Moundville, and was 63.5 degrees Baumé. One very significant thing about this material, was that it had all the characteristics of crude oil. The San Pedro, Mexico, crude carries 80 per cent gasoline and lighter components, and is 46.6 degrees Baumé. Many of the crudes give off only a few per cent at 300 degrees C. But to find a crude which would give off 99 per cent at 300 degrees C. is something which must be left to future generations. It has not been found in the past.

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*"Petroleum and Natural Gas"—West Virginia Geological Survey, Vol. 1, p. 364.

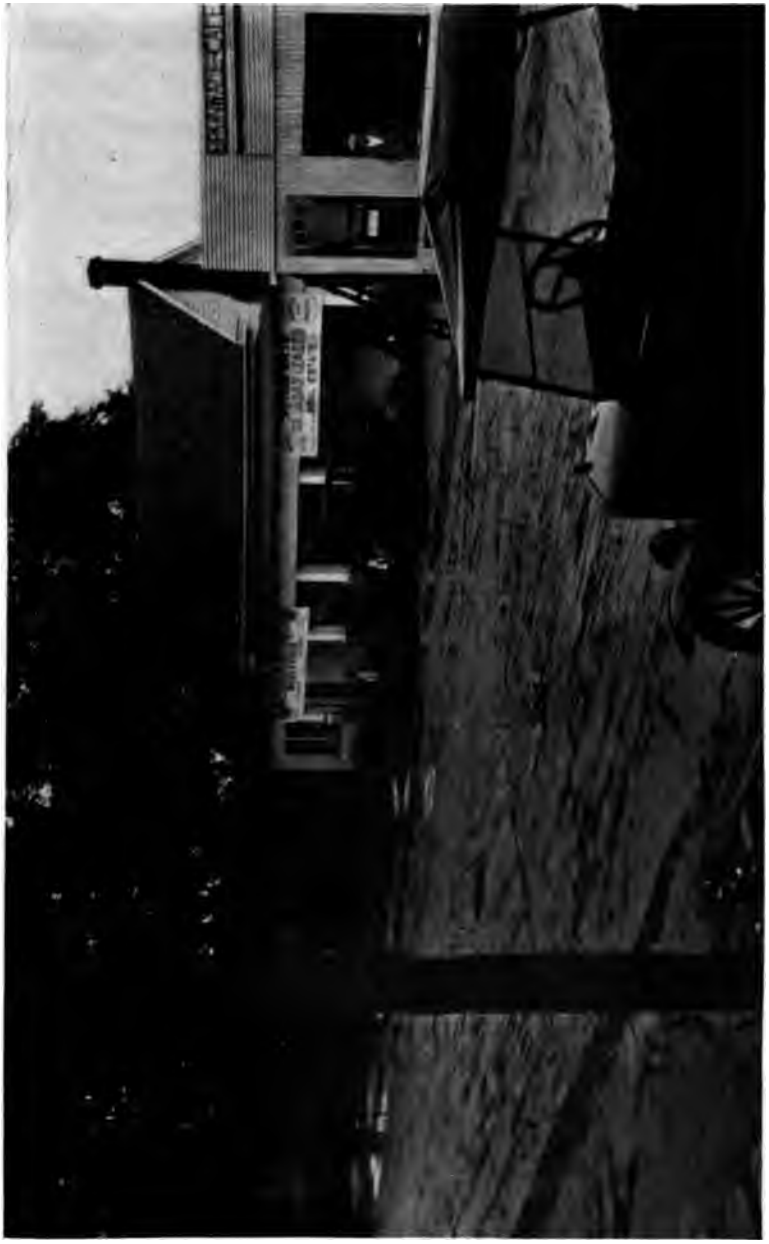
There can be no doubt, therefore, about the accuracy of the findings in this work, and all unbiased citizens in the communities involved, as well as in the State at large, are urged to think carefully over the facts and apparent deductions therefrom, for their own information and perhaps for their own welfare. To invest in such things as these, is to surely lose the entire amount.

It is the contention of the Survey that booms and excited operations, which are fighting overwhelming odds against success, leave in their wake disgruntled and disappointed investors. This is not considered to be in the best interests of the State, and therefore, the Survey would like to avoid as much of this sort of thing as possible. There are too many branches of the mineral industry of Alabama where investments give good returns, and the Survey naturally encourages these things.

The chance of making a killing in the oil game sets the average citizen wild with excitement, as nothing else will. When the cold facts are analyzed, it will be seen that more fortunes are lost than are made. In Alabama alone, something like fifteen million dollars have been invested in prospect wells for oil and gas and the return on the investment is generously estimated at ten thousand dollars.

The policy of the Survey is to encourage rather than discourage prospectors who go about their work deliberately, in an honest effort to find oil or gas in paying quantities, and who locate these prospects in the most favorable territory. On the other hand, the Survey does wish to discourage operations based on such evidence and flimsy excuse as has been presented in the recent booms. The writer is well aware of the real estate scrambles (see Plates 1 and 2) which follow or accompany these periods of excitement, and the infusion of oil experts, promoters and wizard drillers into the game, and that these people are apt to be the only ones to make anything out of it. There have been many instances where men who class themselves as expert drillers from the Pennsylvania or Texas or Oklahoma or some other oil field, come into a region and ride the band wagon in order that funds might be raised to drill a test well, *under their management*. Business men who ordinarily abhor unsafe methods, never seem to be able to see through such projects. The presumption of such

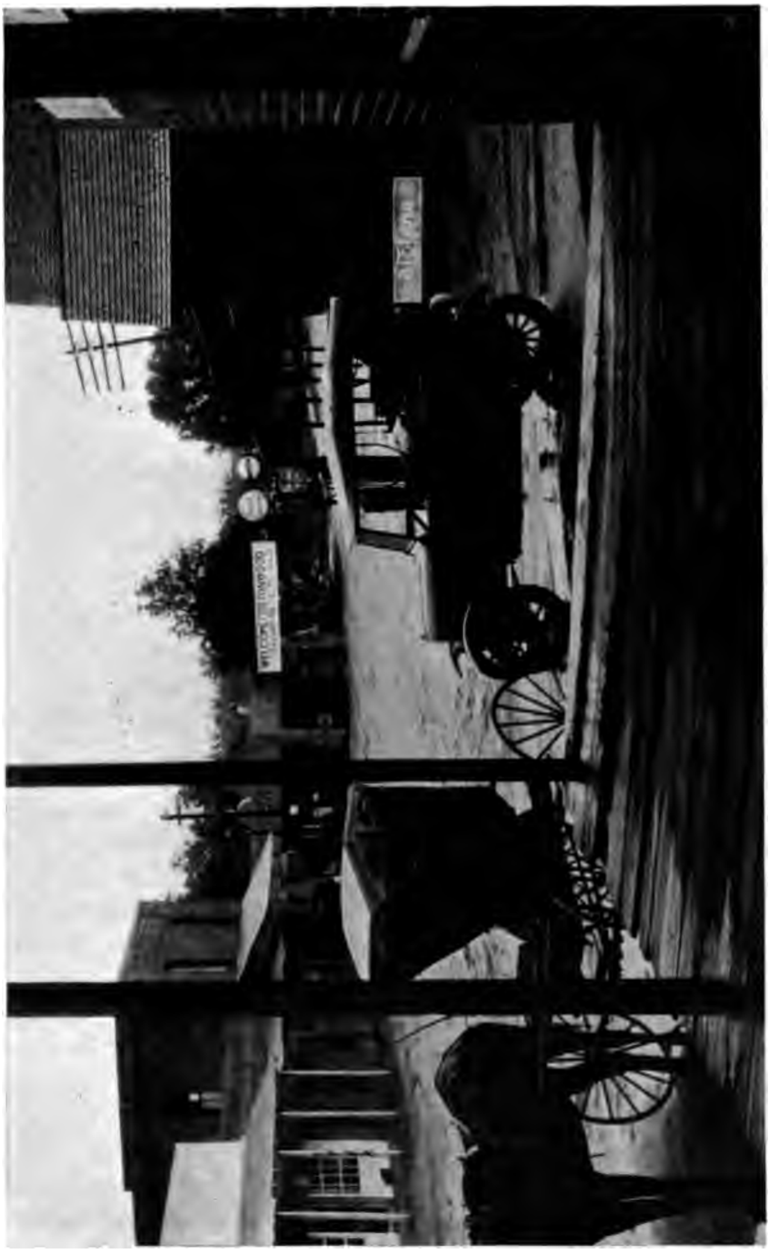
PLATE 1



No. 658. View in Cottonwood, showing temporary offices.

Photo—Dr. Walter B. Jones, June 10, 1927.

PLATE 2



No. 659. View in Cottonwood, showing main street and three filling stations

Photo—Dr. Walter B. Jones, June 10, 1927.

promoters is hardly equalled in any other profession or line of business.

HISTORY

Pell City. The first occurrence brought to the attention of the Geological Survey was at Pell City, in Calhoun County, where a shallow well near the school house had a showing of material similar to gasolines on the market at that time. This occurrence was investigated by Arthur J. Blair, Geologist for the Tennessee Coal, Iron & Railroad Company. Mr. Blair told the writer in conversation recently, that there was no doubt in his mind but that the occurrence was a refined product and not natural. (See figure 1, curves 3 and 6.)

The Pell City occurrence was in clays weathered from limestones of Ordovician age. The rocks in that area are practically on end, and the writer regards the entire section to be without the slightest chance for the occurrence of oil or gas in paying quantities.

Pine Hill. The next area reporting this kind of material was Pine Hill, where a shallow well was said to be making several gallons of the fluid daily. The sample sent to the Survey was remarkably pure, (see figure 1, curve 4) and was found to run automobiles without overheating.

The Pine Hill occurrence differs from that at Pell City in that the general regions is in the second best section in Alabama for oil and gas in commercial quantities. The beds at Pine Hill are Tuscahoma Sands of Eocene age.

Gurley. The third occurrence is at Gurley, in Madison County. This was brought to the attention of the writer on June 25, 1925, and a small sample of the material was given him for analysis. After careful examination of the sample, it was decided that this also was a refined product (see figure 2, curves 3 and 5). Since that time, many samples of the Gurley material have been sent to the Survey. These have varied from almost pure benzine, which obviously had not been subjected to weathering agencies the least bit, to low-grade kerosene. Such a variety of materials could hardly come from the same source, and accordingly the matter was listed as a closed incident. Persistent reports from the

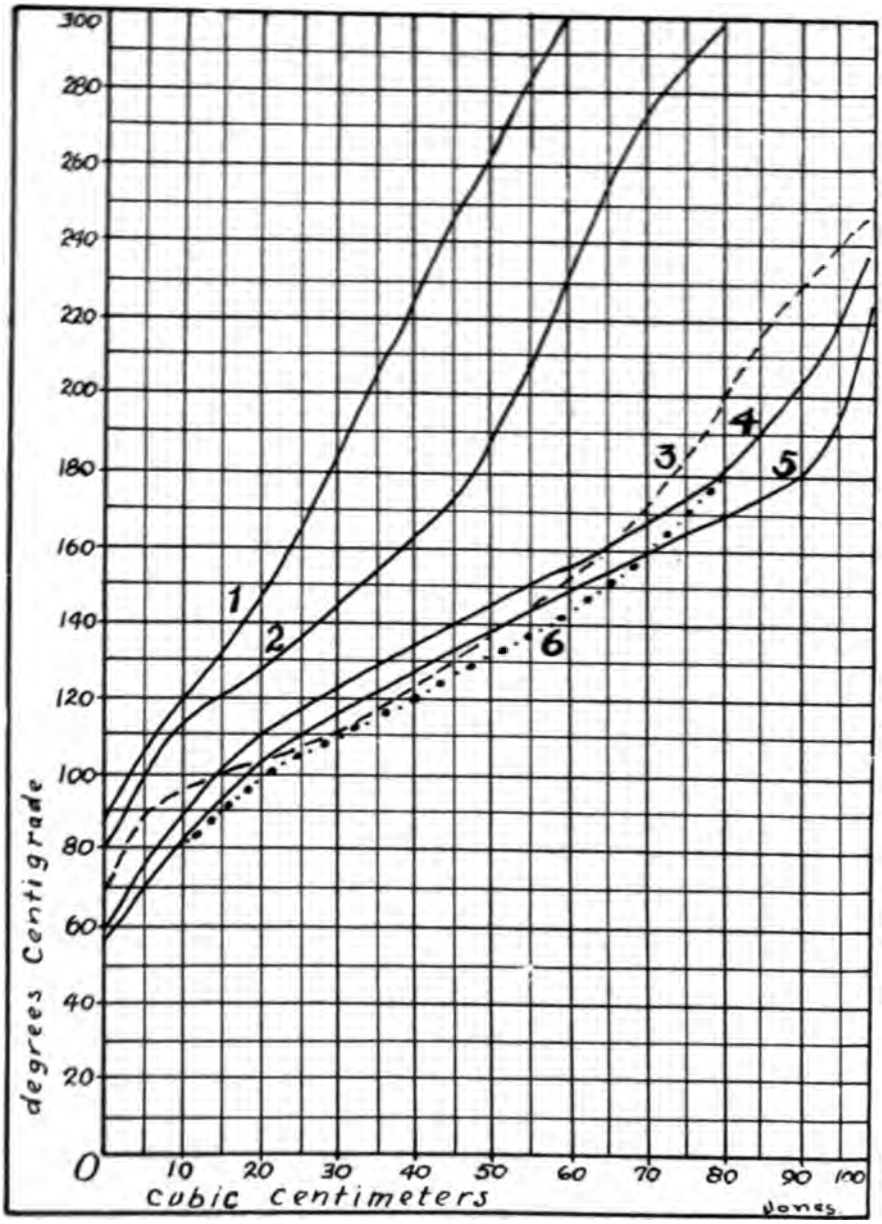


FIGURE 1. *Distillation curves.*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
3. Gasoline from Pell City, Calhoun Co. well.
4. Gasoline from Pine Hill, Wilcox Co. well.
5. A commercial gasoline, fresh from storage tank.
6. Gasoline from Pell City, Calhoun Co. well.

Dr. Robert S. Hodges, Analyst.

region, to the effect that all storage tanks had been taken up and examined, without discovering any leaks, failed to change the inevitable conclusion that the material was refined and thus had no bearing whatever on the possible occurrence of oil and gas in the region.

Gurley is located in an area which is favorable for gas in commercial quantities, but oil is unlikely, in the opinion of the writer. The rocks at that place belong to the Bangor Limestone group of upper Mississippian, and the Trenton can be easily reached by the drill.

This occurrence is given a different aspect from the others, however, by the fact that a well is now being drilled by the citizens of the community to prove or disprove the source of this material. The writer predicts that the well will not be successful, since it was not located with regard to structure, but because of the pollution of shallow wells in the vicinity by gasoline.

COTTONWOOD

The latest occurrence to be personally investigated by the author is that at Cottonwood. The accompanying sketch (see figure 3) will show the general lay-out of the town, and its polluted water wells. It appears that this was first noticed about ten years ago when the well now listed as Johnnie Bruner's, showed some fumes during the process of cleaning it out. The first definite recognition, however, was when S. A. Barker collected some of the material from his well at the grist mill, and set it on fire. This was more than a year ago.

The writer had seen several notices of the occurrence in various newspapers, but his first definite information was contained in a letter from Mr. Herman Gunter, State Geologist of Florida. Mr. Gunter visited the place in company with Dr. L. C. Snider of the Henry L. Doherty Company, late in May. It might be well to state here, by the way, that Dr. Snider regarded the occurrence as one of escaping gasoline, and remarked that there are innumerable such happenings throughout the extent of the operations of his Company. This account of Mr. Gunter's was accompanied by a sample, which was analyzed by Dr. Hodges (see figure 4, curve 2) and found to be a refined product, similar in every way to

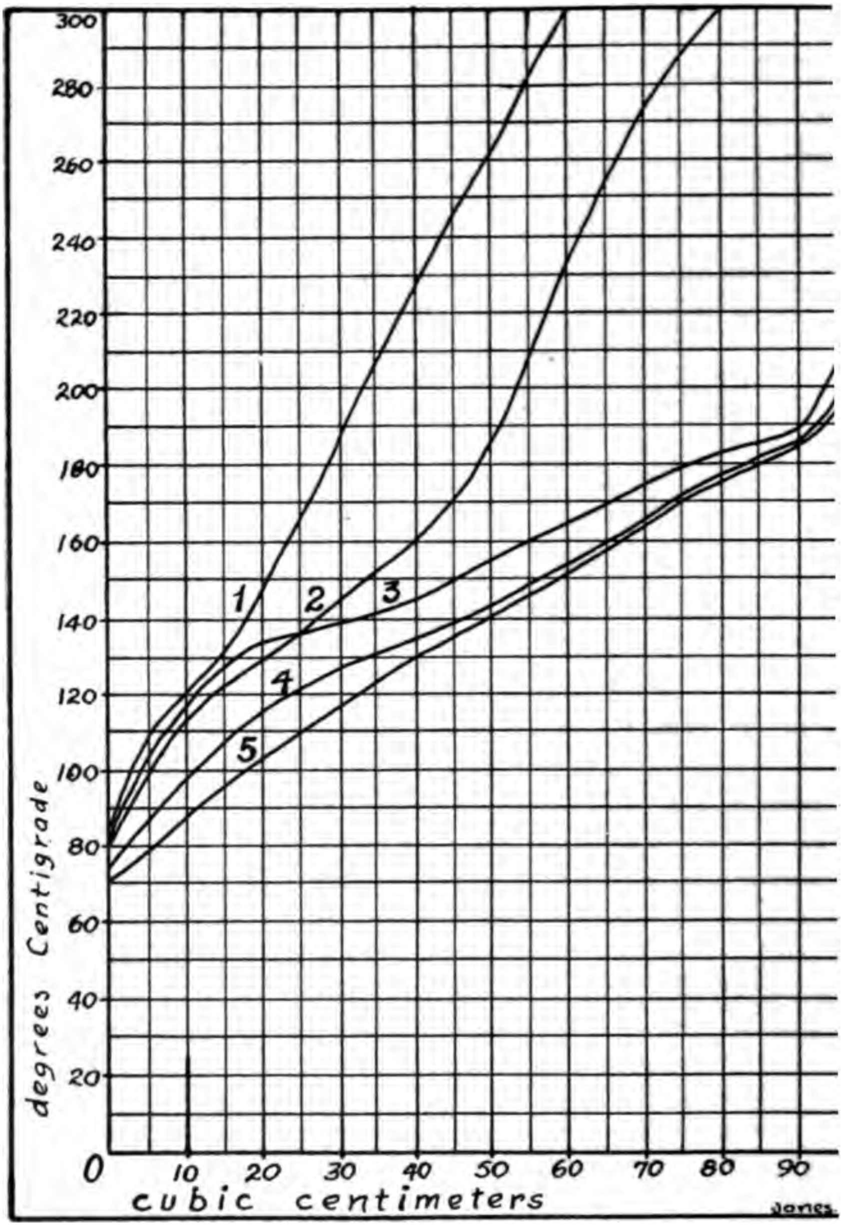
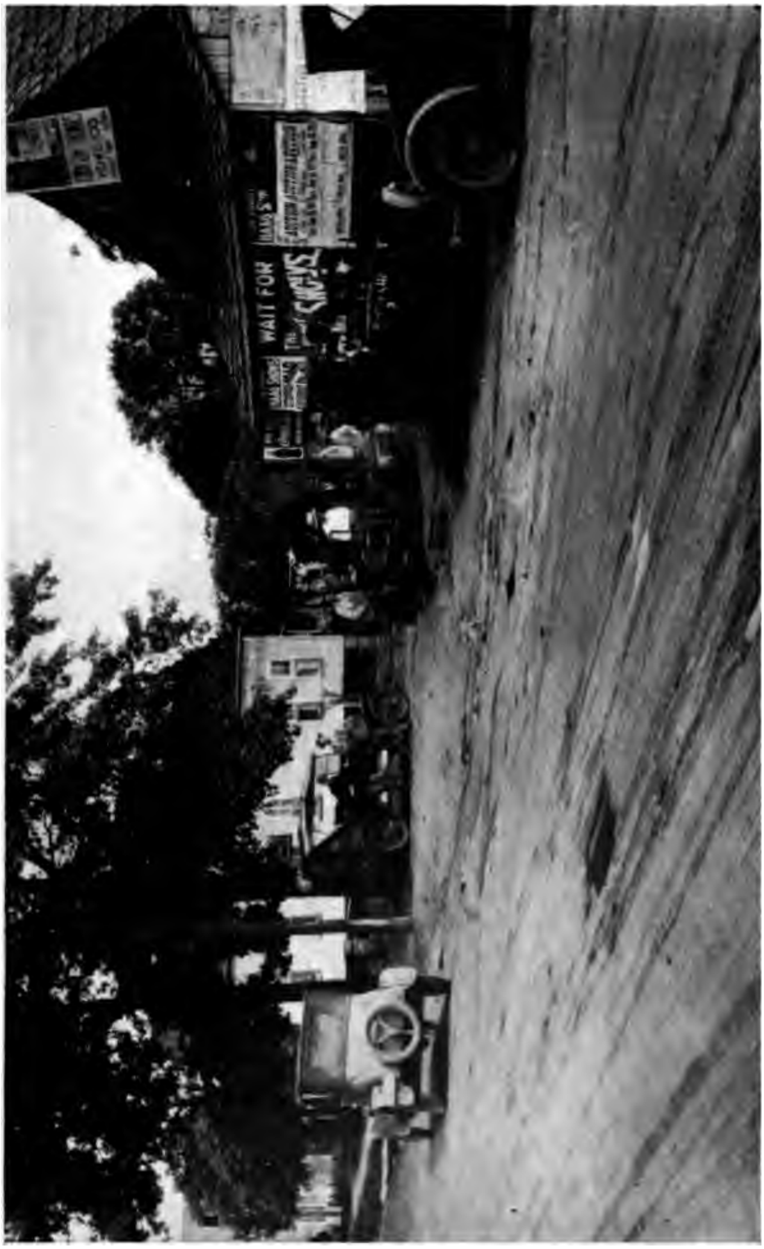


FIGURE 2. *Distillation curves.*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
3. Gasoline from Gurley, Madison Co. well. Sample by Williamson.
4. A commercial gasoline, fresh from storage tank.
5. Gasoline from Gurley, Madison Co. well. Sample by Grayson.

Dr. Robert S. Hodges, Analyst.

PLATE 3



No. 661. S. A. Barker's grist mill and well showing gasoline, and the McAllister well and residence.

Photo—Dr. Walter B. Jones, June 10, 1927.

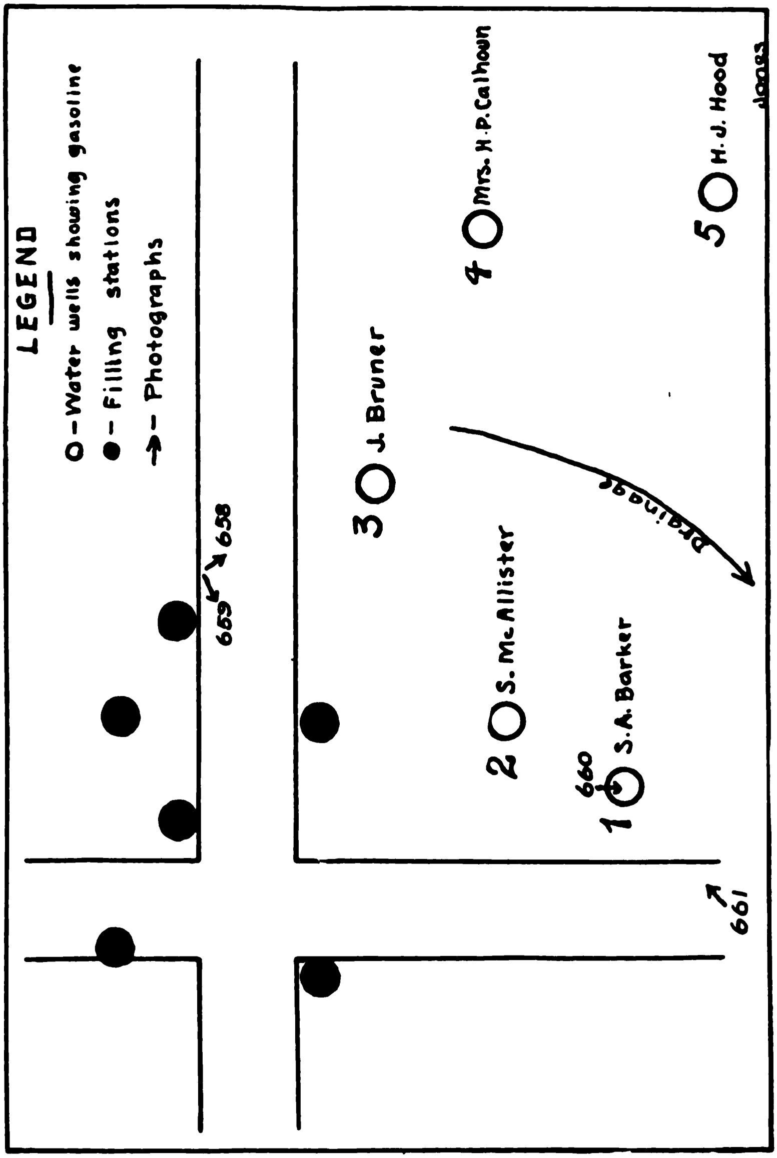


Figure 3. Sketch of Cottonwood, showing location of filling stations, and wells which have been polluted with gasoline. The locations are approximate only.

gasoline. The writer laid aside pressing duties and went to Cottonwood on June 9 and 10, to try to ascertain the facts in the case.

Upon the author's arrival in Cottonwood, a dozen sample jars were received through the kindness of Mr. S. O. Smith, for samples. Climbing down the pump line into Mr. Barker's well (see Plates 3 and 4) in spite of the fumes, a sample was secured. Although one could see an oil substance (see Plate 4) on top of the water, the film was so thin that not more than one-sixteenth of an inch shows on top of the water in the jar. Mr. Barker got a small amount from the drum. On the morning of June 10, Mr. Barker had his pump running, and there were some three gallons in the barrel. This had the same properties as that taken from the barrel on the previous afternoon, and showed signs of weathering. In perfect frankness, the writer believes that the material measured represents at least three days accumulation, with the exception of what had been given away. It would be difficult to determine the amount of liquid which comes into the well daily, but it is thought that it would not exceed three or four quarts. There was hardly more than eight ounces on the well the afternoon before, and the figure of three or four quarts daily is believed to be just about the truth. However, the exact amount which the wells make has nothing to do with the source of the material.

On the next morning, the McAllister well was drawn off, and a film of the material obtained, which was not more than half an ounce, and this too little to test. Johnnie Bruner drew off his well, and Mr. Barker siphoned off the water, getting about a half pint of gasoline. This material was considerably weathered and it was said that the well had not been drawn off for weeks. The curve of the distillation of the Bruner sample was more like a mixture of kerosene and gasoline, and was much more thoroughly weathered than the Barker sample.

Samples could not be obtained from the Calhoun and Hood wells, and it is understood that there are others which came in later. However, these will not change the situation in the least, but only serve to accentuate the greatest extent of the pollution.

Source. The source of the material is undoubtedly from leaks in gasoline tanks in the vicinity. Some one has been losing gasoline, and the loss has been rather considerable. Mr. S. O.

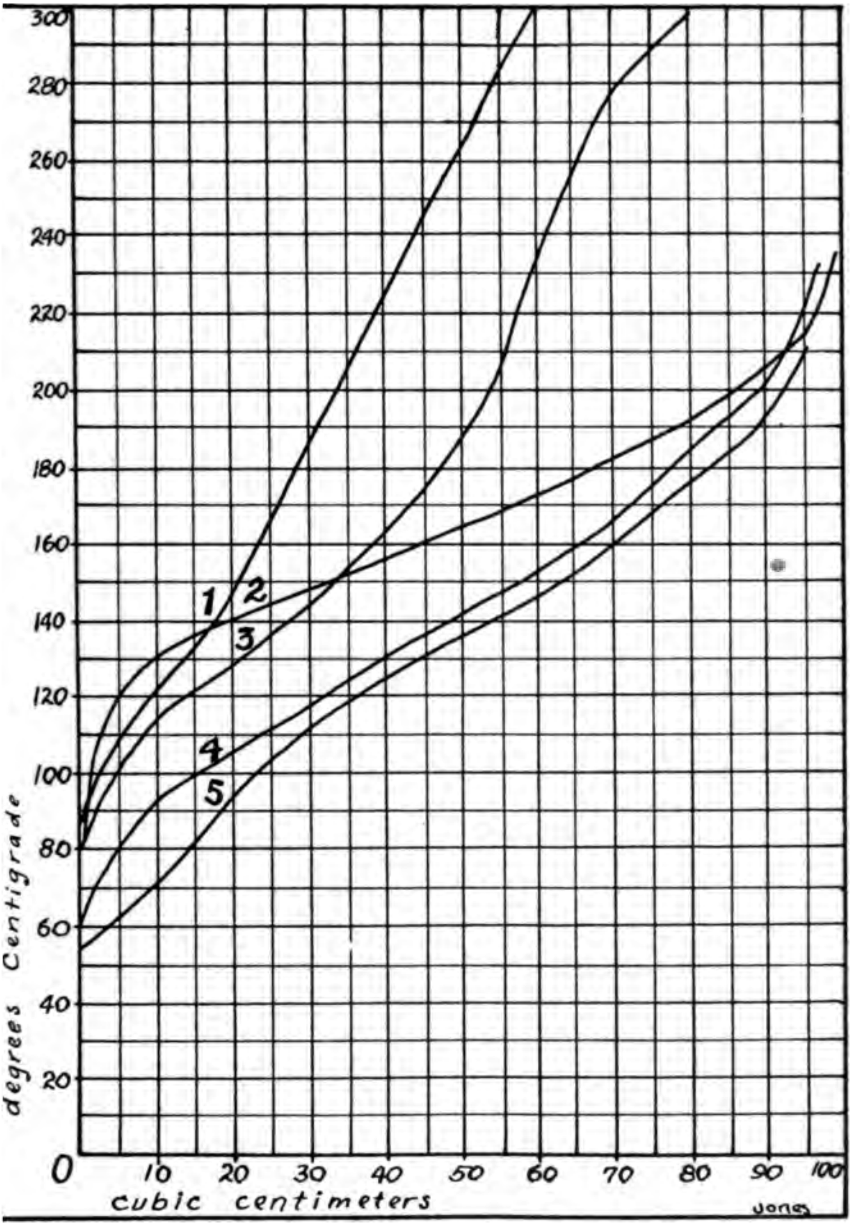


FIGURE 4. *Distillation curves*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Gasoline from S. A. Barker well, Cottonwood, Houston Co.
3. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
4. Gasoline from McAllister well, Cottonwood.
5. A commercial gasoline, fresh from storage tank.

Dr. Robert S. Hodges, Analyst.

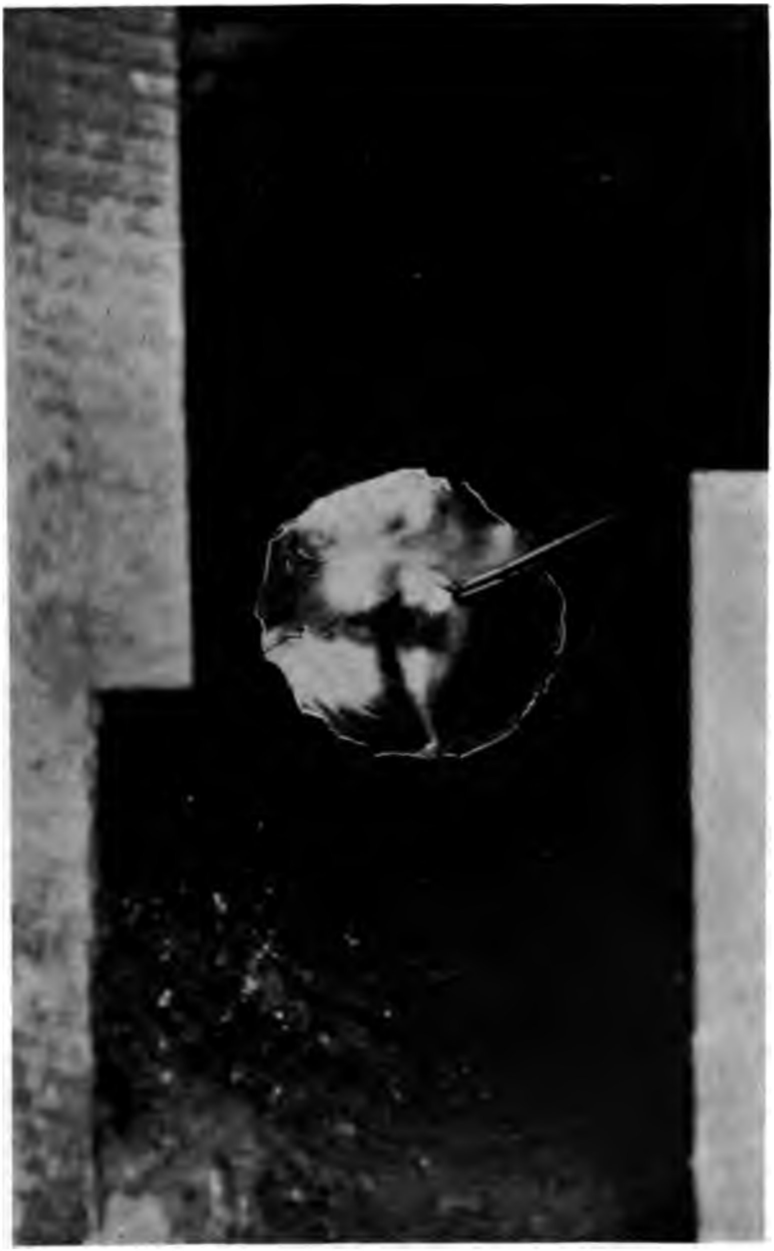
Smith stated that he could not say whether he had been losing gasoline or not. He has not kept a check on the amount received from the trucks and subsequently delivered to the cars. Even if the wells are not making more than three or four quarts a day it means that a large quantity of the material has escaped. It is quite easy to picture a leak, and the gasoline quickly diffusing into the porous sandy clay, which makes up the surface at Cottonwood. Naturally the material would follow along the water channels with the water supply, and into the wells. The complete passage from any of the filling stations to the Barker well would not require more than a few weeks. It would not be at all surprising if the tank or tanks responsible for the pollution were leaking at the present time.

After getting into the ground, all of the stuff would remain above the plastic, impervious clay, which makes up the subsoil throughout the section. That is one reason why the material invariably enters at the bottom, and along with the water supply. Each well ends at the top of this clay, for that is the source of the water in the area.

All of the wells in question have been dug many years. Even if the material were crude oil, it is unlikely that it would suddenly appear in a well which had been dug for such a long time. A statement of Dr. I. C. White, State Geologist of West Virginia and the father of petroleum geology, contained in a recent letter, with his permission, is reproduced in part below:

> "You are undoubtedly correct in your conclusion that the water pollution mentioned is due to a leak from gasoline or oil tanks. I have known many such occurrences when the source was many hundred feet distant, the polluting oil or gasoline appearing to pass along fissures in the stratified rocks until finding an exit into wells. A case of this kind has recently occurred in Pennsylvania where oil had been reported in a well a long distance, several miles, from any pipe line and it undoubtedly got into the well from a leaking pipe of the region. Where oil or gasoline suddenly appears in wells it may be set down as absolutely certain that the source is not from a natural reservoir like the earth strata but from some artificial source either near or far distant."

PLATE 4



No. 660. Looking into Barker's well, showing pump line, and streams of water carrying a film of gasoline, entering the bottom of the well.
Photo—Dr. Walter B. Jones, June 10, 1927.

CHEMISTRY

Petroleum is a very complex substance containing essentially hydrogen and carbon, with various impurities like sulphur, nitrogen and the like. There is a wide range in specific gravity, color, odor, and viscosity. Some of the Mexican crudes are black and do not flow well through the pipe lines without heating. Other crudes are wine-colored or yellowish and might be about the same gravity as gasoline or even higher. Usually natural gas composed of hydrocarbons in a gaseous state is associated with crude petroleum. Natural gas is used frequently from the casing-head for the manufacture of gasoline and for blending with low grade gasolines.

The composition of petroleum cannot be gone into fully in this paper. Practically, the things which are of the greatest importance are the motor fuels and lubricating oils, obtained from refining crude petroleum. During refining there is produced, among other things, napthas, benzine, gasoline, kerosene, various grades of lubricants, heavy engine oil, cup grease, and finally a residuum of asphaltum or paraffin. Since the principal market among the lighter products is for gasoline, every effort is made to produce the very maximum amount of that substance. Naptha, benzine or even the by-product of coal, benzol are mixed with low-grade gasolines to bring them up to standard. In addition to this, the crudes are subjected to various processes of "cracking" to partially break up the heavier components into materials which can be employed for motor fuels.

The term gasoline is used in this report to mean "any mixture of light hydrocarbons intended for use in any kind of vaporizer." Gasoline usually has a gravity of 60 to 75 degrees Baumé, when marketed for use in auto engines. Kerosene usually ranges in gravity from 44 degrees to 49 degrees Baumé. Most of the material between 49 degrees and 60 degrees Baumé is used for blending with lighter material for gasoline.

The apparatus used in our laboratory for analysis of samples is very simple, consisting of a retort and condensing tube, the latter having a water jacket to facilitate condensation. A thermometer is placed in the open end of the retort and sealed. Heat is applied to the liquid, and the first drop going over into the

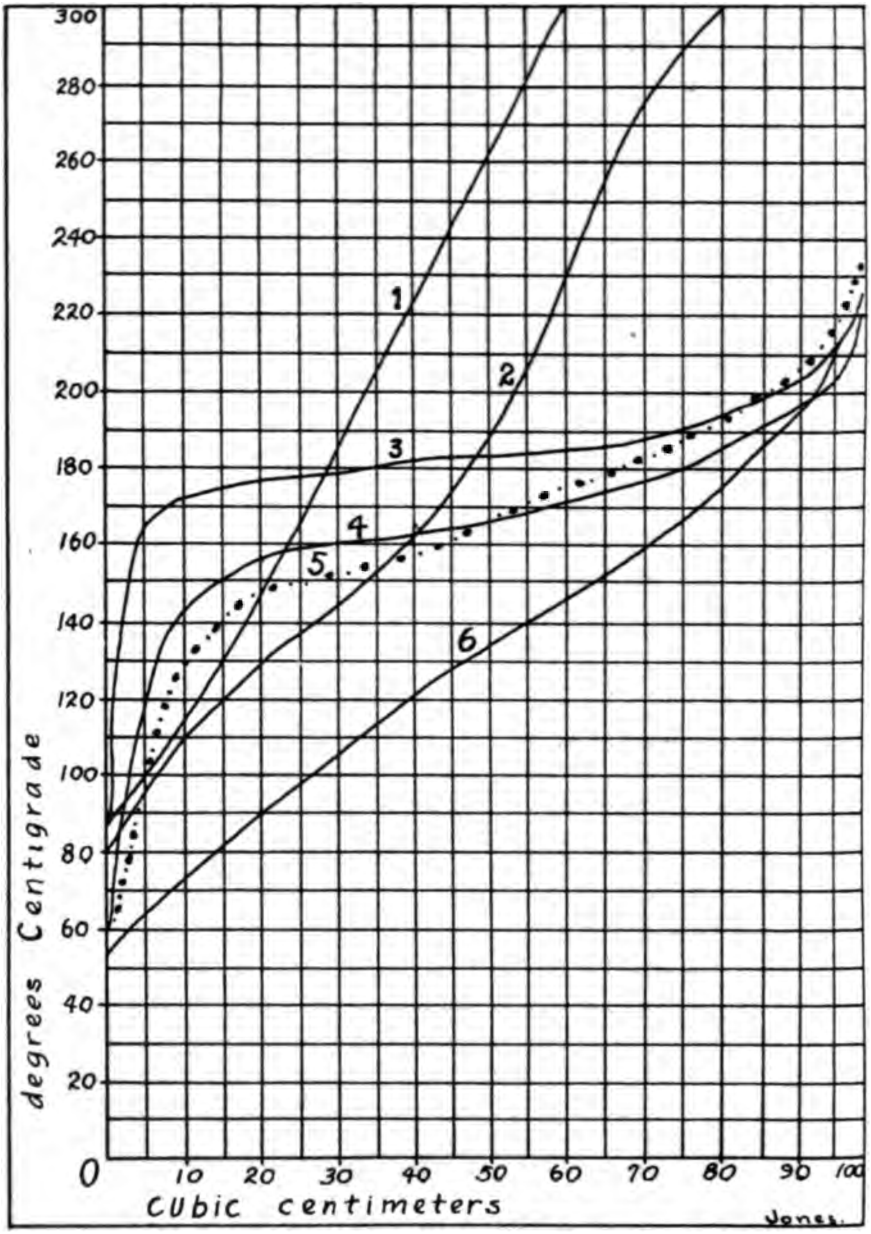


FIGURE 5. *Distillation curves*

1. Crude oil from Pennsylvania, gravity 41° Bé.
2. Crude oil from San Pedro, Mexico, gravity 46.6° Bé.
3. A commercial gasoline, allowed to evaporate for 5 days.
4. Ditto, after 3 days evaporation in air.
5. Gasoline from Barker well, Cottonwood, Houston Co.
6A. Commercial gasoline, fresh from storage tank.

Dr. Robert S. Hodges, Analyst.

condenser is regarded as the boiling point of the liquid. The maximum evaporation and condensation under atmospheric pressure takes place within the range of 300 degrees Centigrade. Any liquid which might remain at that point has to be further distilled in a vacuum. This part of the analysis is not carried out in our work.

In the examination of the samples, there are a few important factors in the determination of the identity of the product. For instance, if the distillation curve shows 90 to 95 per cent going over at or before 200 degrees Centigrade, it is quite likely that the material is gasoline, or if the curve shows most of the liquid evaporated by 300 degrees, it is likely to be kerosene. On the other hand, if 20 to 80 per cent goes over by 300 degrees, the material could be regarded as a mixture of lighter or heavier hydrocarbons, and might be crude oil. In a word, crude petroleum is a complex mixture of hydrocarbons of various gravities, and accordingly has a wide range in its distillation curve, while all of the refined products, even in mixtures, invariably show limited ranges.

Thus, it would hardly be possible for the laboratory technician to fail to determine accurately whether or not any sample was crude or refined. This point the writer wishes to emphasize, in order that those who would go to the trouble of questioning the results, might be prepared to present facts and not someone's guess or opinion.

Distillation Curves. In figures 1, 2, 4 and 5, are presented distillation curves of selected crude oils from Pennsylvania and Mexico, and gasoline samples from the various occurrences under discussion. For comparison, the same crude oil curves are used in each case. The commercial gasolines were selected at random, and distilled under precisely the same conditions and in the same apparatus as the various samples which were sent to the office, or collected by members of our staff, from Cottonwood and the other places. Since we are not advertising gasolines, we have withheld the names of the brands used. These will be supplied upon request.

In figure 1, there is a remarkable resemblance between the curves for commercial gasoline, and the samples sent us from Pine Hill and Pell City. Only one sample, No. 3 from Pell City, showed even the slightest effect of weathering or evaporation.

The other samples were undoubtedly pure gasoline, and unquestionably refined. The last 20 per cent of No. 4 Pine Hill and No. 6 Pell City showed identically the same curve.

In figure 2, there are some interesting conclusions to be drawn. It will be noticed that No. 5 from Gurley has a lower initial boiling point and curve up to 50 cc. This sample evidently is a high test gasoline, or gasoline blended with some such substance as benzol, several kinds of which are on the market at the present time. No. 4 in this figure represents fresh commercial gasoline, and No. 3 another Gurley sample. This last named curve suggests that the material had been evaporating for several days before it was collected. The end points of all these samples are practically the same.

In figure 4, the curves are somewhat different. Commercial gasoline is represented by No. 5, while No. 4 was given the writer by a citizen of Cottonwood, and was said to have come from the McAllister well. It will be remembered that the sample secured by the writer from that well was too small to test. The McAllister well sample is practically pure, only a small amount of the most volatile components having been removed by evaporation. On the other hand, the sample from the Barker well showed signs of considerable evaporation. Again, the end points are essentially the same. The sample of commercial gasoline showed nearly 4 cc. lubricating oil, and was unusual in that respect. Nearly all gasolines leave a residue of 1 to 2.5 cc. at 300 degrees Centigrade, but 4 cc. is unusual. It might be mentioned here that the largest residue recorded from any of the samples from Pell City, Pine Hill, Gurley or Cottonwood was 2.5 cc.

An effort was made to produce some results which could be more easily explained to the layman or non-technically trained person. At the author's suggestion, Dr. Hodges purchased 5 gallons of commercial gasoline, mixed the whole amount with water and clay, in a container which was left open at the top. After mixing, a sample was distilled. This is the No. 6 curve. The mixture was stirred, at intervals, to increase the thoroughness of evaporation. After three days, the lighter components escaped as is shown in No. 4 curve. After five days, only a few hundred cubic centimeters of the original five gallons remained. A sample of this residue was distilled, and the results presented in No. 3 curve. In comparison with these, a sample from the Barker well was distilled and is shown in No. 5 curve. This is the basis for the writer's suggestion that the Barker samples were at least three days old. It is quite likely that they may be older than that, for evaporation would not be so active in the bottom of a well, as it would in a window in a laboratory, in an open vessel. Another point of interest is that the samples evaporated in the laboratory invariably turn yellow, upon exposure, which is the color of nearly all of the samples from the localities under discussion. It might be said also that any sample which does not show a yellow or pale lemon color, is quite pure gasoline.

From the curves in figure 5, it is easy to see that the gasoline loses its lighter components, and the residue represents the heavier, less volatile fractions. The results of this experiment can be applied directly to any of the other samples. It was explained that most gasoline was composed of light hydrocarbons ranging in gravity from 60 to 75 degrees Baumé. The components at the 75 end would evaporate first, of course. Smaller portions of the others would go off also, but the change of the fluid from a mixture of 60 to 75 would gradually develop into a preponderance of heavier components at the 60 end. A distillation curve of the final 100 cubic centimeters residue from the evaporation of 50 or 10 gallons would be almost a straight line from 5 to 90 cc., and in addition to this, the temperature would remain between 180 and 200 degrees Centigrade, or near the upper end of range of heat needed to carry out the evaporation for gasoline. This is clearly shown in figure 5, curve No. 3.

The details of the distillation tests are presented in the following tables:

Cubic Centimeters	No. 1	2	3	4	5	6	7	8	9	10
	Degrees Centigrade									
0	80	55	60	60	80	55	80	120	60	80
5	165	65	......	......	......	......	120	......	......	......
10	172	72	145	130	130	70	130	150	95	137
20	177	90	156	141	140	95	140	155	105	154
30	178	107	158	151	150	110	150	160	117	164
40	181	122	163	159	159	125	159	164	130	180
50	184	135	166	167	166	135	166	168	142	186
60	186	145	171	176	174	145	174	174	152	200
70	189	160	177	184	......	160	......	178	165	210
80	195	175	185	194	193	175	193	185	185	227
90	203	195	194	206	205	190	205	195	200	255
95	210	210	202	217	217	210	217	206	217	290
99	225	......	220	232	......	......	235	210	230	300
Gravity										
Deg. Bé.	44.6	59.4	47.7	48.8	......	......	......	......	......	46.6

No. 1. Commercial gasoline, No. 1 brand, after 5 days evaporation.
" 2. Commercial gasoline, No. 1 brand, fresh.
" 3. Commercial gasoline, No. 1 brand, after 3 days evaporation.
" 4. Gasoline samples from Cottonwood, No. 1 A., Barker well, July 7.
" 5. Gasoline sample from Cottonwood, No. 1 A., Barker well, July 16.
" 6. Commercial gasoline, No. 1 brand.
" 7. Gasoline sample from Cottonwood, No. 1, Barker well.
" 8. Commercial gasoline, No. 1 brand, evaporated to one-half its original volume.
" 9. Gasoline sample from Cottonwood, McAllister well.
" 10. Gasoline sample from Cottonwood, Bruner well.

Cubic Centimeters	No. 11	12	13	14	15	16	17	18	19
	Degrees Centigrade								
0	160	80	75	75	50	60	......	......	80
5	......	......	110	......	65	......	......	90	150
10	195	115	125	......	80	90	80	......	165
20	202	127	135	115	105	110	100	104	170
30	207	145	140	......	120	124	110	110	175
40	215	160	145	130	130	134	120	124	180
50	220	185	155	......	142	144	132	138	185
60	226	230	160	150	156	154	143	154	190
70	233	275	170	160	164	170	160	176	195
80	240	300	180	175	175	180	180	200	205
90	253	......	200	195	188	204	205	224	215
95	265	......	220	......	200	220	220	......	230
99	276	......	230	210	210	232	......	240	235
Gravity Deg. Bé.	......	46.6	52.3	......	......	56.0	......	......	49.0

No. 11. Commercial kerosene.
" 12. Crude petroleum from San Pedro, Mexico.
" 13. Gasoline sample from Gurley, by Mercer Williamson.
" 14. Gasoline sample from Gurley, by D. A. Grayson.
" 15. Commercial gasoline, No. 2 brand.
" 16. Gasoline sample from Pine Hill.
" 17. Gasoline sample from Pell City, No. 1.
" 18. Gasoline sample from Pell City, No. 2.
" 19. Gasoline sample from Cottonwood, Barker well.
Sent by Mr. Herman Gunter.

Conclusion. At first glance, it seems ridiculous that such occurrences as those discussed in this paper should require a second thought. Occurrences of gasoline have never been known in nature. The nearest approach was some external light crude in West Virginia, with a gravity of 67 degrees Baumé. This crude had all the characteristics of crude petroleum, however, and was limited in quantity. On the other hand, occurrences of gasoline in shallow wells have been reported from all over the United States, in rocks representing every age from earliest or Pre-Cambrian to recent sands at the seashore. It has been the experience of those working with crude petroleum and its refined products, that it is not at all difficult to differentiate between the mother liquid and its products, even in mixtures. The cases in Alabama have been very easy to determine, and thus little time was spent in explanation.

It is hoped that the data presented in this paper will serve to set at rest all unbiased minds. Those who still question the conclusions reached by us are urged to send samples to any reputable chemist for analysis.

The writer wishes to again state that this circular was not prepared to discount the chances of finding oil or gas in Alabama, but to set at rest for all time, the rumor that occurrences of gasoline in shallow wells are signals to drill for oil at those points.

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GEOLOGICAL SURVEY OF ALABAMA

WALTER BRYAN JONES, STATE GEOLOGIST

CIRCULAR 5

SUMMARY OF THE DISTRIBUTION AND OCCURENCE OF THE ROCK-ASPHALT DEPOSITS OF ALABAMA

BY
WALTER B. JONES, PH. D.
STATE GEOLOGIST

UNIVERSITY, ALABAMA
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BIRMINGHAM PRINTING COMPANY
BPCo
PUBLISHERS

LETTER OF TRANSMITTAL

UNIVERSITY, ALABAMA,
June 7, 1928.

HON. BIBB GRAVES,
Governor of Alabama,
Montgomery, Alabama.

Sir: I have the honor to transmit herewith the manuscript of a report entitled "Summary of the Distribution and occurrence of the Rock-Asphalt Deposits of Alabama," with the request that it be printed as Circular Number 5 of the Geological Survey of Alabama.

Very respectfully,

WALTER B. JONES,
State Geologist.

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INTRODUCTION

During recent years much information has been obtained from various sources concerning the extensive deposits of rock-asphalt in northwest Alabama. The demand for this type of material along with other construction materials, has brought about a determined effort to ascertain the quantity and quality of this asphalt-bearing rock, and to present such facts as may have a direct bearing upon the extension of its scope of usefulness.

The object of this report is to present some of the salient features of the present status of the industry in Alabama, and its future possibilities, based on extensive field work and much detailed prospecting.

HISTORY

Apparently the first published account of the occurrence of asphalt rock in Alabama was that given by Tuomey,* who noted tar springs in Lawrence County, nine miles south of Oakville, where the springs exuded from a stratum about 50 feet from the top of the limestone (Bangor). These places had been known to hunters much earlier than that, and had been used as a watering place by John Prince in 1840. The tar made into pills was said to possess distinct curative properties.

McCalley† gives several accounts of occurrences of tar springs as well as asphaltic sandstones and limestones and states (p. 60) that the strata are "highly fossiliferous or crinoidal limestones and coarse grain sandstones. Several carloads of the black bituminous sandstone from the top of Little Mountain south of Leighton have been shipped to Memphis as an experiment in the extraction of its asphaltum or mineral tar."

Little else has been carried in Alabama Survey reports, until the investigations carried on by Clark‡ were published. These investigations were largely completed before actual production began.

During the last few years much diamond drill prospecting has been done in the lime rock areas, and large bodies of satisfactory grade ore outlined.

---

*Tuomey, M. Second Biennial Report on the Geology of Alabama, State of Alabama, p. 41, 1858.

†McCalley, Henry, Report on the Valley Regions of Alabama. Part 1. On the Tennessee Valley Region. xxvii + 436 pp. 1896.

‡Clark, G. H. Rock Asphalts of Alabama and their use in Paving. Special Report 13, Geological Survey of Alabama. 1925.

GEOLOGY

The type section in northwest Alabama is as follows:

Pennsylvanian	*Top*
Coal measures, forming the northern margin of the Coal region of Alabama.	
Mississippian	
Bangor Limestone, making up the Moulton-Russellville Valley.	
Blue massive bedded limestone, abundantly fossiliferous and carrying occasional coral reefs	200′
Intertongue of oolitic limestone (Burgess Oolite)	0′-40′
Blue, fossiliferous limestone, thin to thick bedded, coarse to medium-grained	100′
Intertongue of oolitic limestone (Rockwood Oolite)	0′-55′
Light blue to gray limestone, and thin layers of shale, all abundantly fossiliferous	100′
Hartselle Sandstone, medium to fine-grained sandstone, massive bedded, gray and sparingly fossiliferous	200′
Golconda, confined to Colbert County, made up of thin-bedded limestone and green marl or clay, sparingly fossiliferous	0′-35′
Cypress, confined to Colbert County, massive sandstone	0′-40′
Gasper, made up of oolitic limestone, light gray and massive bedded; compact lithographic limestone and green shale. Abundantly fossiliferous, and in all about	120′
Bethel, massive bedded sandstone, medium to fine-grained, gray, unfossiliferous, not over	20′
St. Genevieve, oolitic limestone in eastern Tennessee Valley and soft green shale or marl in Colbert County, with a two-foot bed of limestone at the base, carrying myriads of *Productus inflatus*. Abundantly fossiliferous, and about	75′
Tuscumbia Limestone, massive bedded, gray to blue, cherty limestone, fossiliferous	100′
Lauderdale Chert (Fort Payne), evenly bedded chert, with upper portions weathering readily into float material. Fossiliferous, with an abundance of crinoid stems	200′
Devonian or Carboniferous	
Chattanooga Black Shale	0′-40′

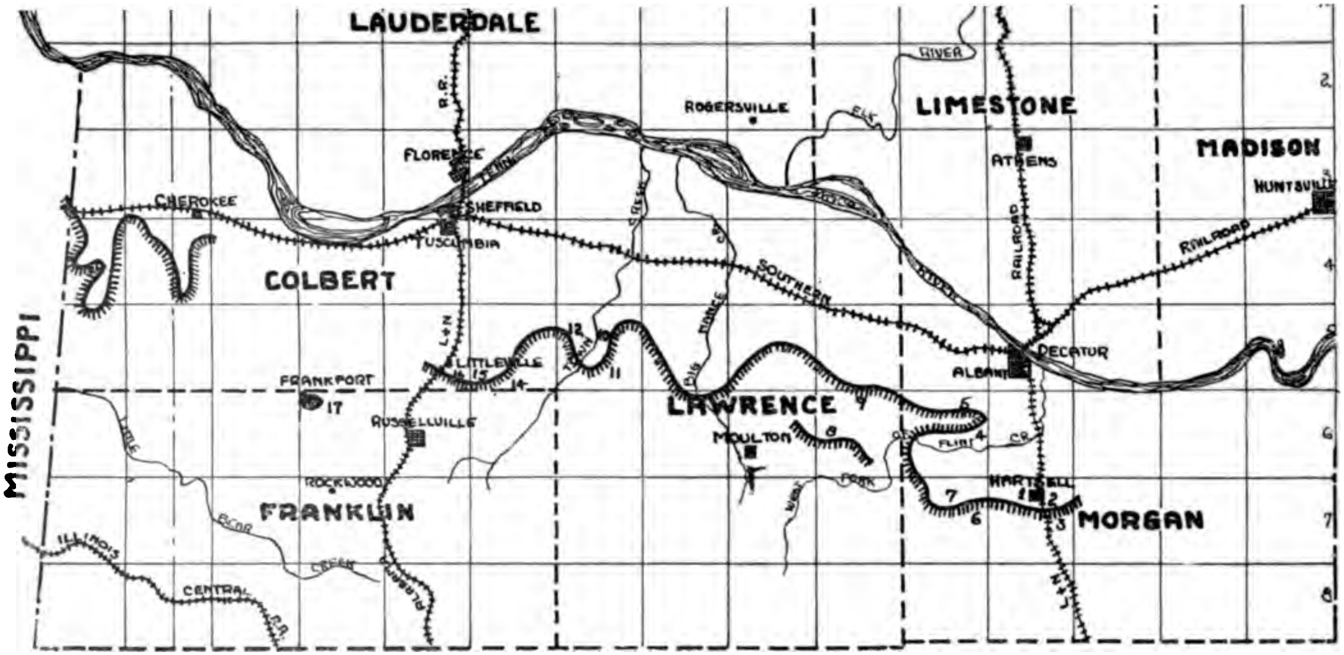


PLATE 1

Map of Northwest Alabama showing the approximate location of asphaltic beds in the Hartselle, Gasper and Bethel formations. Note that there are at least two asphaltic horizons in the Hartselle and perhaps more.

Some prominent Hartselle outcrops are as follows:

Morgan County

1. Hartselle deposits
2. Pollak Tract
3. Parker Tract
4. Hamrick Tract
5. Day Tract
6. Adams Farm
7. Name unknown

Lawrence County

8. Clanton Tract
9. Cappo and Kitchen's Mill
10. Wolf Springs Area
11. Pool and Willis Traces
12. Jeffries Tracts

Colbert County

13. Shine Spring area
14. Aycock Graveyard
15. King Tract
16. Douglas Tract

Franklin County

17. Frankfort area

OCCURRENCE

Rock-Asphalt deposits (See Plate 1) in Alabama include both sandstones and limestones, and are found in the Bangor, Hartselle, Gasper and Bethel formations, the asphaltic part of the Gasper being entirely confined to northwest Alabama. As can be seen from the foregoing section, the Hartselle and Bethel are sandstones, while the Bangor is a massive bedded, highly fossiliferous limestone and the Gasper on oolitic limestone. Most of the tar springs came from the Bangor limestone, probably because of the fact that this formation makes up the sharp descent into the Moulton Valley from the escarpment of Sand Mountain, thus giving fresh asphalt and heavy asphaltic oil ready access to water channels. These members will be discussed in the order given above.

Bangor: The occurrence of asphalt in the Bangor probably does not reach commercial proportions, since the known areas are scattered and exist more in the form of tar springs or seeps, and as shows in various wells drilled in the region.

Important occurrences are as follows:

Morgan County, Andrews Chapel, S 20 T 8 R 5 W.
Stentson Mine, S 10 T 8 R 3 W.

Hartselle: The asphaltic zones in the Hartselle cover a larger area than either of the others and comprise rather extensive reserves of material carrying satisfactory bitumen content. The thickness ranges up to some 20 feet, while the asphaltic content varies from traces to samples which have "frog eyes" of pure asphalt standing out all over the exposed surfaces. A typical section is that ¾ mile southwest of Frankfort, (See Plate 2) as follows:

Bangor Limestone

Hartselle

30′—Thin bedded sandstone, with some lean rock near base.
2′—Slaty sandstone, oozing asphalt.
18′—Asphaltic sandstone, uniform asphaltic sandstone in bed of creek.

The beds impregnated with asphalt extend from Hartselle in Morgan County westward at least to Frankfort in Franklin County. A list of some of the more important deposits is as follows:

Morgan County

Hartselle area:

L. & N. passenger station, in cut (1).
Foundation for business block in Hartselle (1).
Shoal Creek, east and southeast of Hartselle (1).

PLATE 2

A. Outcrop of the uppermost beds of the Hartselle formation, near Frankfort, Franklin County. The beds are dipping northward at this point.

B. Outcrop of the upper asphaltic member of the Hartselle in creek ¾ mile south of Frankfort.

Photos Dr. Walter B. Jones, March 9, 1928.

Pollak tract, S. 11, T. 7, R. 4 W. (2).
Parker tract, S. 14, T. 7, R. 4 W. (3).

Flint area:

Southern Rock Asphalt Co., Inc., Louisville, Ky.
Hamrick tract, S. 12, T. 6, R. 5 W. (4).
Day tract, S. 13, 2. 6, R. 5 W. (5).

Miscellaneous:

Adams farm, S. 13, T. 7, R. 5 W. (6).
S. 10, T. 7, R. 5 W. (7).

COLBERT COUNTY

Littleville area:

Douglas tract, about ½ mile south of Littleville, (16).
King tract, S. 36, T. 5, S. R. 11 W. (15).
Aycock Graveyard, S's. 31 and and 32, T. 5, R. 10 W. (14).
Shine Springs area, S's. 28 and 33, T. 5, R. 10 W. (13).

FRANKLIN COUNTY

Frankfort area, in tributary of Cedar Creek, for at least a mile. (17).

LAWRENCE COUNTY

Cappo area, in Sections 3 and 10, T. 6, S. R. 6 W. (9).
Kitchen's Mill tract, in Sections 9, 10, 15, 16 and 21, T. 5, S. R. 9 W. (10).
Pool tract, S. 21, T. 5, S. R. 9 W. (11).
Willis tract, S. 21, T. 5, S. R. 9 W. (11).
Jeffries tract, S. 16, T. 5, R. 9 W. (12).
Clanton Prospects, S. 23, T. 6, R. 6 W. (8).

Gasper: So far as is known commercial deposits of asphalt rock belonging to this formation are confined to Colbert County (See Plate 3) and extend from Cherokee westward to the State line. The outcrop is practically continuous over all of this area, and many accurate measurements made with a hand level. The oolitic part of the Gasper is about 25 feet thick in Colbert County, but the portion impregnated with asphalt is quite variable. The thickest outcrop seen by the writer was about 4 miles south of Margerum, where 20 feet of asphaltic limestone was exposed on a hill-side (See Plate 4 A). An outcrop about 6 miles west of south of Cherokee, in what is known as the Basin Area, showed 15 feet, and a well dug near the creek at this point was said to have penetrated an additional 15 feet. The well has since filled up with [illegible] and this point could not be verified. Material thrown from [illegible] probably average four percent asphalt, in spite of weathering.

An outcrop (See Plate 4-A), in the western portion of S. 13, T. 4, R. 14 W., gave the following section:

Tuscaloosa—gravel to top of hill.

Gasper—

2′—cap rock of hard, flinty limestone, barren.

20′—Asphaltic oolite, massive bedded and scattered boulders showing differential weathering.

120′—Shaly limestone, thin bedded and abundantly fossiliferous.

Bethel—

8′ plus—Asphaltic sandstone to bottom of hill.

Two plants have been producing limerock asphalt for several years, and recently steps have been taken to increase the capacity. The plant of the Alabama Rock Asphalt, Inc., located about 1 mile south of Margerum, has just been completed, while the Colbert Limerock Asphalt Company, operating just east of Cherokee, has added a second crusher to its plant.

Bethel: The outcrop of the Bethel is approximately the same as that of the Gasper, although the Bethel extends much farther eastward, (See Plate 1). In general, the asphaltic content of the Bethel is somewhat higher than that of the Gasper, due to the fact that the sandstone has greater porosity than the limestone. The only place where the Bethel has been thoroughly prospected is directly south of Cherokee, where the Cherokee Rock Asphalt Company opened up a quarry and produced a small amount of sandrock asphalt. This plant has been shut down for about two years.

ANALYSES

No.	Formation	Location	Asphalt	Method	Analyst
1.	Bethel	Weaver Tract, Colbert County	2.73%	S	R. S. Hodges
2.	Do.	O'Reilly Tract, Colbert Co.	8.26%	S	Do.
3.	Do.	Hargett Tract, Colbert Co.	5.64%	S	Do.
4.	Do.	Rutland Tract, Colbert Co.	4.60%	S	Do.
5.	Do.	O'Reilly Tract, Colbert Co.	10.45%	S	Do.
6.	Do.	Do.	14.90%	I	Do.
7.	Do.	Hargett Tract, Colbert Co.	5.56%	S	Do.
8.	Do.	Do.	8.91%	I	Do.
9.	Do.	Rutland Tract, Colbert Co.	4.88%	S	Do.
9½.	Do.	Do.	5.78%	I	Do.
10.	Gasper	SW¼, S. 12, T. 4, R. 14 W.	4.62%	S	R. S. Hodges
11.	Bethel	Cherokee Rock Asphalt Co. Colbert Co.	6.41%		Picard Lab.
12.	Do.	Norton Tract, Colbert Co.	9.56%	I	Jones & Breckler
18.	Do.	Turner Tract, Colbert Co.	10.85%	I	Do.
14.	Do.	Hargett Quarry, Colbert Co.	11. 2%	I	Do.
15.	Gasper	Ashcraft Quarry, Colbert Co.	8. 7%	.	R. S. Hodges
(a)	Hartselle	NW¼ of NW¼ of S. 10, T. 6, R. 6, Lawrence Co.	4. 5%	I	Do.
(b)	Do.	Southern Properties, Morgan Co.	4. 4%	I	Do.
		Do.	7.44%	I	Do.
(c)	Do.	Same sample	6.85%	S	Do.
(d)	Do.	Sandlin Tract, Morgan Co.	8. 3%	I	Do.

S—Soluble in Carbon bisulphide.
I—IGNITION

PLATE 4

A. Typical exposure of the Gasper formation, in S. 13, T. 4, S. R. 15 W., Colbert County. This is the thickest outcrop seen by the author. (March 12, 1928.)

B. Outcrop of the Bethel asphaltic sandstone three miles southwest of Tuscumbia, Colbert County. The overlying shales usually cover the Bethel with debris, and good exposures are scarce. March 9, 1928.)

Photos—Dr. Walter B. Jones.

No. 1. Badly weathered sample from outcrop. Collected by Clark, 1923.
2. Selected sample, taken by Clark, 1923.
3. Average sample, collected by Clark, 1923.
4. Do.
5. Selected sample, by Clark, 1923.
6. Same sample.
7. Average sample, collected by Clark, 1923.
8. Same sample.
9.
10. Random sample, taken from weathered outcrop by Clark, 1923.
11. Details of sample not given.
12. Average of 4 core drill holes.
13. Do.
14. Average of 43 core drill holes.
15. Sample drawn from 10 foot section, by Clark, 1923.
(a) Clark, 1923.
(b) Systematic sample over 13½ feet, by Clark, 1923.
(c) Sample from Southern Properties by Clark, 1923.
(d) Samples from Section 16 and 21, T. 8, R. 4, W.

No.	Formation	Location	Asphalt	Method	Analyst
16.	**Hartselle**	Willis Tract, Lawrence Co.	9.4 %	..	R. S. Hodges
17.	Do.	Pool Tract, Lawrence Co.	7.7 %	..	Do.
18.	Do.	Jeffries Tract, Lawrence Co.	9.1 %	..	Do.
19.	Do.	Clanton Tract, Lawrence Co.	3.8 %	.	Do.
20.	Do.	Pollah Tract, Morgan Co.	5.5 %	I	Do.
21.	Do.	Parker Tract, Morgan Co.	6.87%	I	Do.
22.	Do.	Southern Property, Colbert Co.	4.4 %	I	Do.
23.	Do.	Douglas Property, Colbert Co.	6.53%	..	Do.
24.	Do.	King Tract, Colbert Co.	4.33%	..	Do.
25.	Do.	Do.	3.24%	..	......
26.	Do.	Shine Springs Tract, Colbert Co.	8.54%	.	......
27.	Do.	Do. average of 9 drill cores	4.16%	.	......
28.	Do.	Shine Springs Tract, Colbert Co.	5.89%	S	R. S. Hodges
29.	Do.	Do.	7.20%	S	Do.
30.	Gasper	Ashcraft Quarry, Colbert Co.	6.95%	S	Do.
31.	Do.	Col-Rock Quarry, Colbert Co.	4.74%	S	Do.
32.	Hartselle	Wolff Springs Tract, Lawrence Co.	9.1 %	I	Do.
33.	Do.	Do.	7.51%	I	Do.
34.	Gasper	Ashcraft Quarry, Colbert Co.	7.53%	S	Do.
35.	Do.	Col-Rock Quarry, Colbert Co.	3.22%	S	Do.

16. Systematic sample taken over 7½ ft. of outcrop by Clark, 1923.
17. Systematic sample taken from 8 ft. exposure by Clark, 1923.
18. Average rich sample from 8 ft. of exposed strata, by Clark, 1923.
19. Average sample from 10 ft. of strata, Clark, 1923.
20. Average sample from 4 ft. tunnel face, by Clark, 1923.
21. Average from face 6 to 8 ft. high, by Clark, 1923.
22. Average from a face of 13¼ ft., by Clark, 1923.
23. Average of 8 ft. of outcrop, by Clark, 1923.
24. Composite taken from weathered material drawn from a well, by Clark, 1923.
25. Core of 11 ft. from report of Julian Kendrick, Birmingham.
26. Average over 8 ft. of outcrop, by Clark, 1923.
27. Average from 9 drill hole cores, from report of Julian Kendrick.
28. Average from outcrop by Jones, 1928.
30. Selected sample, by Jones, 1925.
31. Average sample by Jones, 1928.
32. Selected sample from outcrop, by Jones, 1925.
33. Average sample from outcrop by Jones, 1925.
34. Selected sample, by Jones, 1925.
35. Average from first car crushed, August 4, 1925, by Jones.

RESERVES

The writer considers it just as important to give the methods of determining reserves as to give the actual figures obtained. From the various reports of consulting engineers, it appears that no rock is considered which carries more than 50 feet overburden, and most of them determine quantities with 0 to 25 feet burden, and 25 to 50 feet. In most instances this has been done by acreage. The author has gone carefully through several of these reports, and has come to conclusion that there are 250,000 tons of rock asphalt per mile outcrop per foot thickness of the bed, with less than 50 feet overburden. It was necessary to determine such a figure, and this result is an average of two calculations, and is considered as nearly correct as can be reached with the information at hand. In turning cubic yards into tonnage, it is considered that one cubic yard equals two (short) tons, and all the figures are reached in that way.

Gasper: Much detailed drilling has been done in the Col-Rock quarry, and a quarry site 700 feet wide and 2640 feet long, almost without overburden, and with a bed 9 feet thick, gives 16,632,000 cubic feet or 616,000 cubic yards, or 1,232,000 tons. Since this quarry is one-half mile long, we have 273,776 tons per foot thickness per mile outcrop. Although this is a selected figure, it should be remembered that it is based on practically no overburden, and that to calculate the amount with 50 feet or less burden, the total would be much greater.

Another figure which may be considered a fine average example is the Basin property in Sections 5, 8, 16, 17, 20, 21, 28, and 29, T. 4, S. R. 14 W., where a careful survey shows 325 acres with less than 25 feet burden and 145 acres with 25 to 50 feet burden, or a total of 470 acres. This gives, using an average thickness of 9 feet:

43,560 × 470 × 9 × 2 = 13,648,800 tons, and 13,648,800 ÷ 7 = 216,647 tons per mile outcrop per foot thickness.

These two figures give us an average of 242,211, and thus the average of 250,000.

Thus we come to the figures for the reserves of Gasper limerock asphalt. From the map, there appears to be 43 miles of outcrop, and the average thickness is taken as 8 feet, from the measurements shown in Plate 3—43 × 8 × 250,000 = 86,000,000 tons of limerock asphalt under 50 feet of cover.

If the impregnated rock extends for one mile back of the outcrop, we have these figures:

5,280 × 5,280 × 43 × 8 = 9,590,169,600 cu. ft.
9,590,169,600 ÷ 27 = 355,191,466 × 2 = 710,382,932 tons.

Bethel. While the sandrock asphalt underlying the limerock has not been worked out in detail, it is likely that the average thickness is quite as great, and the area twice as great. This will give us 172,000,000 tons under 50 feet burden.

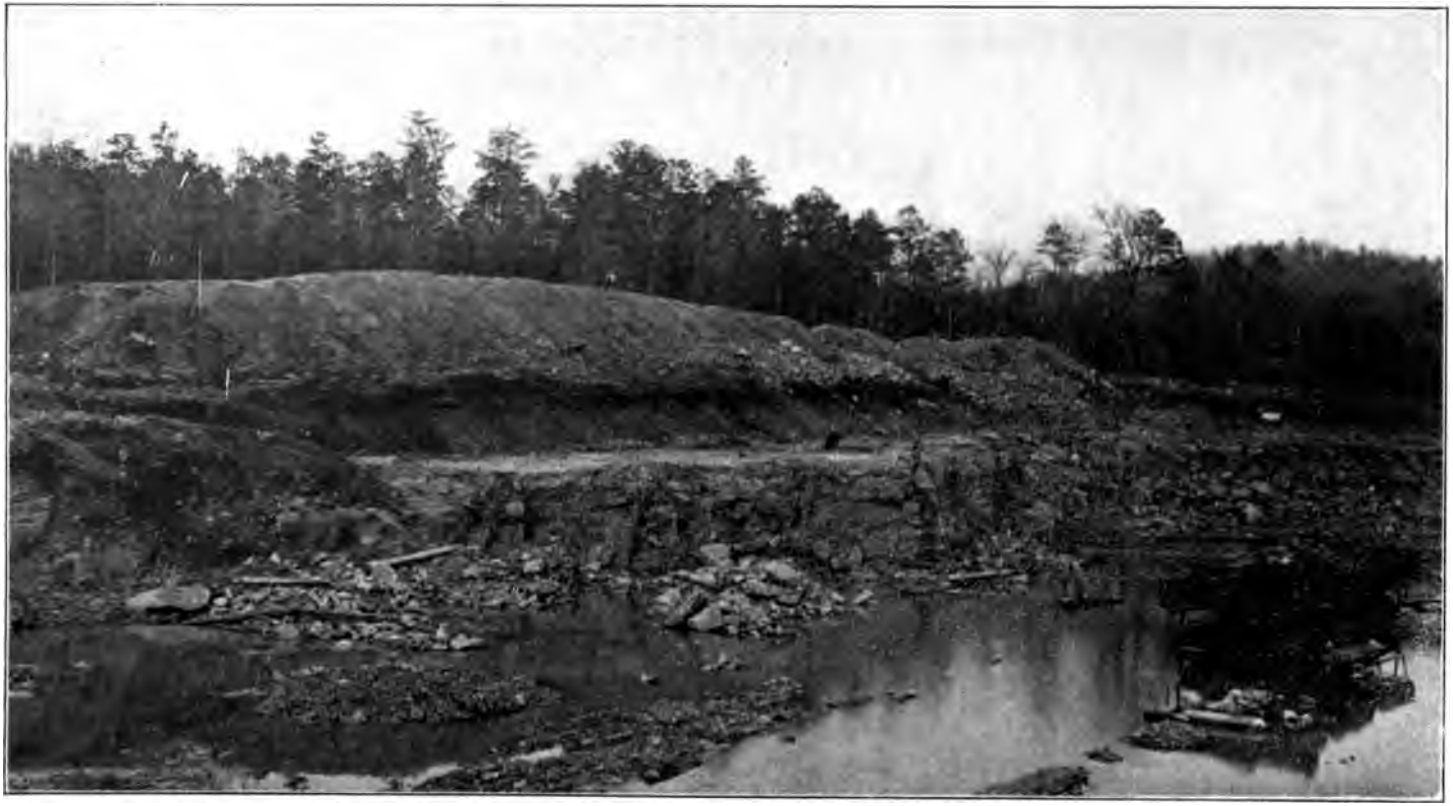
Hartselle. In the absence of detailed information, the writer has made no effort to calculate the available tonnage from this formation. However, considering the great length of the outcrop, and the fact that these are the least two horizons impregnated with asphalt, there must be at least 300,000,000 tons with less than 50 feet of cover.

Remarks. As a practical application of the above figures and to better show the enormous amount of material available, it has been found that 1,000 tons of asphalt rock will lay a pavement 20 feet wide and 1 mile long, and 2 inches thick. There is enough limerock asphalt in the Gasper and with less than 50 feet overburden to lay a 20 foot pavement more than three times around the world. Similar figures can be had for the Bethel and Hartselle.

Future Prospects. From the foregoing pages it is evident that there is a large quantity of both sandrock and limerock asphalt, of commercial grade. A small amount of rock has been used in years gone by, the first of the modern production having been recorded from the Ashcraft quarry (See Plate 5) in 1923, but certainly the industry has not reached anything like the proportions it should have attained. Instead of shipping a car now and then, this material should go out by the train load.

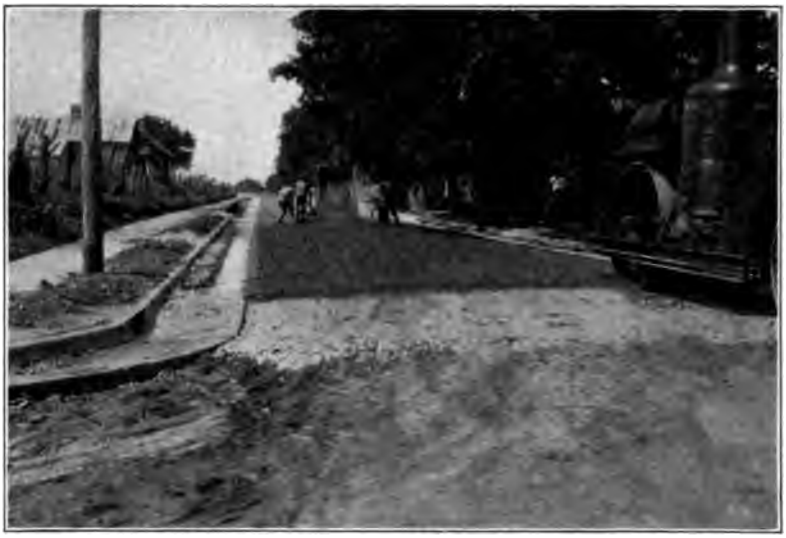
The writer does not attempt to set forth the reasons why this has not been so, but would offer just two suggestions. In the first place there has been more or less lack of cooperation among those who were operating or planning to operate. In the second place, not enough attention has been given to research work in order to determine the best methods of preparing the rock for the market, and under what conditions it will give the best results when laid. If these two points will be considered, it is thought that the industry will be greatly benefited.

There is very strong competition in this particular field, but there is no reason why any well financed and properly operated project should not be successful. The material *has* been used for paving (See Plates 6 and 7), and all indications point to satisfactory results.

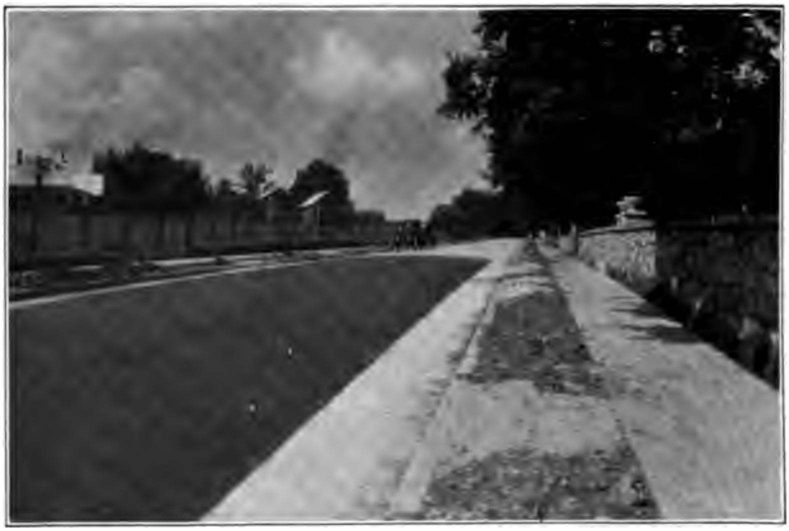


Ashcraft quarry, near Margerum, now owned and operated by Alabama Rock Asphalt, Inc. The asphaltic horizon at this point is unusually rich, and it is a very good quarry site

PLATE 7



A. Laying 2-inch black top of limerock asphalt from the Col-Rock quarry, on a reconstructed limestone base, on California Street, Huntsville.



B. Finished black top section of California Street, and another section ready for the spray of dry Portland cement.

Photos by Dr. Walter B. Jones, August 11, 1926.

C

GEOLOGICAL SURVEY OF ALABAMA
WALTER BRYAN JONES, State Geologist

CIRCULAR [illegible]

SUMMARY REPORT ON THE WATTSVILLE BASIN OF THE COOSA COAL FIELD

BY
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UNIVERSITY, ALABAMA
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GEOLOGICAL SURVEY OF ALABAMA
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CIRCULAR 6

SUMMARY REPORT ON THE WATTSVILLE BASIN OF THE COOSA COAL FIELD

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UNIVERSITY, ALABAMA

1929

BIRMINGHAM PRINTING COMPANY
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PUBLISHERS

LETTER OF TRANSMITTAL

University, Alabama,
February 27, 1929.

Hon. Bibb Graves,
Governor of Alabama,
Montgomery, Alabama.

SIR: I have the honor to transmit herewith the manuscript of a report entitled "Summary Report on the Wattsville Basin of the Coosa Coal Field," with the request that it be printed as Circular Number 6 of the Geological Survey of Alabama.

Very respectfully,
WALTER B. JONES,
State Geologist.

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Figure 1. Sketch map of the Wattsville Basin ....Insert

INTRODUCTION

DURING the first years of the present decade, Watt T. Brown carried on a rather complete program of prospecting in the Wattsville basin, which led to the writer's examination of this area in December, 1924. Some 200 test pits had been sunk into the various seams, affording ideal conditions for studying the thickness and character of the coal.

This basin carries the greater part of the merchantable coal, in the Coosa field, which is the southeasternmost coal field of the Western Hemisphere carrying coal of Carboniferous age.

It might be mentioned that Wattsville was formerly Coal City, the name having been changed early in this year.

The field work of 1924 was carried on in cooperation with Watt T. Brown, whose signal contribution to this report is gratefully acknowledged.

AREA

The Wattsville Basin occupies the north central portion of the Coosa Basin, which covers a part of St. Clair and Shelby counties. The Wattsville Basin, as it will be used in this report and on the accompanying map (see figure 1), comprises what has been heretofore mapped as the Black Ankle, Coal City and Fairview Basins. This area is cut off on the north by the fault which forms the southern extremity of the Ragland Basin, the northernmost of the basins of the Coosa Field. On the southern end of the Wattsville Basin there is no prominent break to designate the boundary between this basin and the Howard Basin, to the South. The southern part of the Coosa Basin is so broken and altered by faulting, that the basin structure is lost.

The Wattsville Basin is located in townships 15 and 16 south and ranges 3 and 4 east of the Huntsville Meridian. The portion of the area which has possible commercial seams of coal occupies about 30 square miles, in a strip some 12 miles long and perhaps 2½ miles wide.

TOPOGRAPHY

The Wattsville Basin is bounded on the northwest by Shoal Creek Mountain; on the west by Rock Pine Mountain; on the west-southwest by Backbone Mountain; on the southwest by a flat rather non-descript country with few topographic features; on the southeast and east by the Coosa Valley; and on the northeast by the Ragland Basin.

On the eastern borders of the basin are a few distinct ridges made up of massive sandstones and conglomerates, which the faulted remnants of the thicker and more extensive beds which make up the mountains to the west.

The basin has a northeast-southwest trend, thus running parallel to the general trend of the Coosa Basin, which is in turn governed by the Appalachian Uplift. The basin itself is characterized by comparatively low ridges running parallel to the general direction of the basin. These ridges often show excellent dip-slopes, especially in the northern part of the area. The northern part is traversed by N. Business Creek, the tributaries of which often cut through the ridges and give a rather rugged aspect to a good portion of the country. The highest hills in this part occur along the marginal fault to the east where the conglomerates and sandstones occur in considerable thickness.

Wattsville is located in the median portion of the basin and is the new station on the Birmingham-Atlanta division of the Seaboard Air Line which cuts diagonally across the basin. On the opposite side of the basin is the old town of Broken Arrow, where the business of the section was carried on prior to the days of the old East & West railroad. When that road was laid, the town largely moved to the present site of the Wattsville post office, where there are still a number of stores and other business houses. Then when the Seaboard located its lines still farther westward, a fair section of the business district migrated to the new location, which is now called Wattsville. The commissary and offices of the Ragland Coal Company are located here also. Later the Seaboard laid a connecting line to Pell City, which is served by the Birmingham-Atlanta division of the Southern.

The southern part of the basin has no distinct topographical features, being a gently undulating country with no prominent marginal ridges. There are no large streams traversing this area, so that the dissection has not proceeded far enough to contribute any very definite features. In the extreme northwestern part of the area lying South of the railroad the existence of the conglomerates, which only appear at this point in the entire basin, makes up some very distinct hills which stand out rather abruptly, due largely to the fact that the rest of the surrounding country is flat.

There are two good roads running through the area. Perhaps the better of these leads northward from Wattsville to a cross-roads near Fairview, one fork leading to Ashville, and the other to Ragland. This same road continues through Wattsville and thence southward along the western side of the basin, finally entering Eden, a point on the Southern just west of Pell City. The other good road leads from Pell City, through old Broken Arrow, and then swerves off to the east into the Coosa Valley and finally to Ragland. There are a reasonable number of fair connecting roads, in good enough repair to enable one to travel readily during most seasons of the year.

GEOLOGY

Historical. Perhaps the first important mention of coal in Alabama was that of Dr. Alexander Jones*, who gave a rather good discussion of the state of the industry at that time, but did not recognize the Warrior, Cahaba and Plateau fields. Various other early writers have mentioned the existence of coals at various places in Alabama, but the first comprehensive discussion of the Coosa Field, as such, was made by Prof. Michael Tuomey†. Prof. Tuomey gave a section across the Coosa Field from Sand Mountain, showing the relations of this field to the adjacent territory. He recognized coal seams on Trout Creek (21 inches, with a 6 inch shale parting); and in the vicinity of Broken Arrow where two seams were seen to outcrop. Each of these latter seams he reported as being 5 feet of clean coal. He regarded the Coosa Field as being a part of the Cahaba Field, and considered that the coal seams were very similar if not identical.

Since that time the field has been clearly recognized, and received more or less attention until 1895, when A. M. Gibson‡ wrote a special report on the area, giving a very detailed discussion and recognized about fourteen seams of what he considered workable coals. This report has remained the only detailed report on the area. In 1912, Dr. W. F. Prouty compiled a map of the Coosa Field from his own notes and observations, and from available notes of other investigators, especially George N. Brewer. This map was published by the Alabama Geological Survey.

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* Silliman's Journal, Volume XXVI, 1834.

† Reports on the Geology of Alabama, part 1, 1850, pp. 75-77, figure 11.

‡ Report upon the Coosa Coal Field, with sections. Special Report No. 7, Ala. Geol. Survey, 1895, 143 pp.

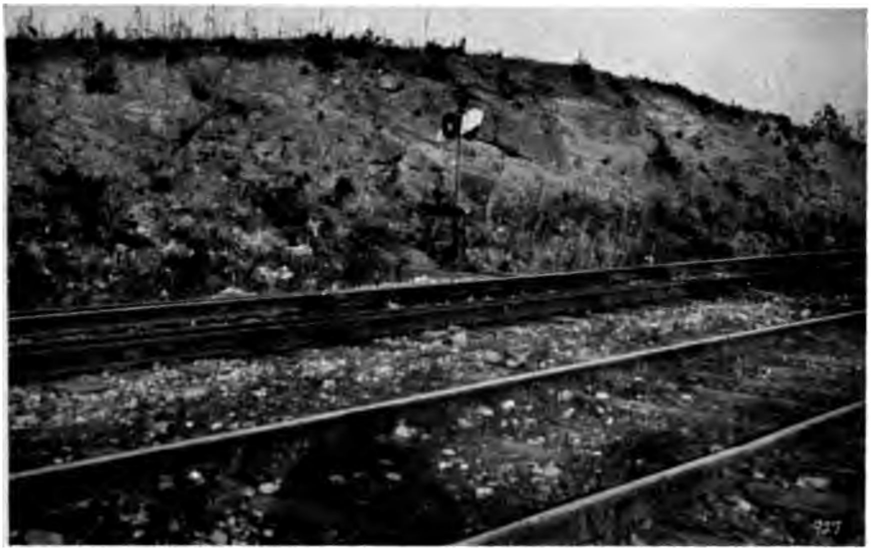
At the time Dr. Prouty's map was published, there were not many openings available for study, which made accurate detailed mapping extremely difficult and hazardous.

Stratigraphy. All of the beds with which we are directly concerned are of Pennsylvanian age, or Upper Carboniferous. It is true that in the valleys to either side of the basin there are beds of Silurian and Ordovician age, but these are not connected with the basin proper, and will not be discussed. The beds which enclose the seams between the Lower Chapman and Hammond seams, inclusive, were the only ones to receive detailed study, and thus all the discussion which follows relates particularly to those beds, unless otherwise noted. The base of the section is hardly known, but near the top the Fourth or Upper Conglomerate provides a tie-point with the other fields.

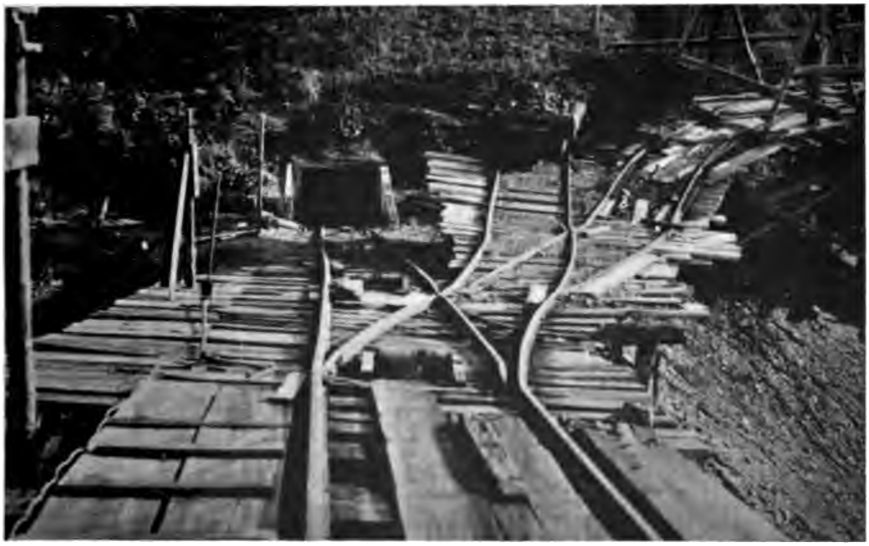
A composite section is as follows:

40' shales, and sandy shales.
(11) 8' ... Hammond (Dirty Dozen) Seam.
20' shales, carrying the Brewer, or shale seam marker.
20' conglomerates (Fourth or Upper Conglomerate).
200' shales and shaly sandstones, all thin-bedded.
(10) 5' .. Coal Branch Seam.
210' shales and sandy shales, very uniform in both thickness and character.
20' sandstones, massive-bedded, heavy ledges.
(9) 5' ... ... Broken Arrow Seam.
5' fire clay.
30' shale, sandy in places.
15' sandstone, massive-bedded.
40' shale.
(8) 4' .. Marion Seam.
10' shale, blue, laminated.
110' sandy shale, thin-bedded, yellowish on outcrop.
60' shale and shaly sandstone.
20' sandstone, massive-bedded to flags, some places rather shaly.
(7) 3' Bibby Seam.
30' shaly sandstones, flags and thin-bedded shaly layers.
10' sandstones, massive-bedded, gray.
30' shales and clay.
(6) 4' Brown Seam.
6' fire clay, bluish-gray to steel-gray.
15' shale.
45' sandstone and shaly sandstones, mostly thin-bedded to flags, bluish-gray.
160' shales, blue to gray.
(5) 2' Clean or Gann Seam.
20' shale, blue, thin-bedded to laminated, in places almost "paper shales," uniform thickness throughout basin.
(4) 3' Higginbotham Seam.
5' sandstone.
20' shale and sandstone, thin-bedded.
5' sandstone ledge.
40' shaly sandstone, thin-bedded to laminated.
75' sandstone, massive-bedded, forms ridges and fine examples of "cuesta" or dip-slopes.
(3) 5' Fairview or Big Seam.
20' shale and shaly sandstone, thin-bedded.
25' sandstone, massive-bedded, gray, somewhat micaceous.
70' shaly sandstone, thin-bedded, yellow to gray, with coal marker or shale seam.
20' sandstone, coarse-grained, massive-bedded, red.

PLATE 1



A. Sandstone above Fairview seam, looking northwest along strike. Higginbotham seam appears in shales at right. One-quarter mile east of Wattsville, S. A. L. tracks, SE¼ S. 36, T. 15, R. 3 E. December 12, 1924.



Photos Walter B. Jones.

B. Looking east into Brown mine at No. 10 opening on Fairview seam. Also shows tracks and loading tipple. NE¼, S. 36, T. 15 S., R. 3 E. December 12, 1924.

(2) 4' .... Upper Chapman or Ragland Seam.
4' fire clay, yellowish.
75' sandstone, thin-bedded with some shaly members, blue to red, weathering yellow.
40' shale, blue to gray, occasional thin layers of reddish sandy shale, very uniform throughout field.
(1) 4' .... Lower Chapman Seam.
5' fire clay, yellow to bluish.
125' shales, laminated, blue to gray, fairly uniform throughout basin, with marker or shale seam at bottom.

Total ..1670'

There were a few variations noted from time to time, but no very pronounced changes were found. The shale member between the Gann or Clean and Higginbotham seams varied from 15′ to 30′, but was usually near 20′ everywhere that it was possible to measure good outcrops. Another change that might be mentioned occurs in the beds overlying the Fairview or Big seam (see Plate 1-A), where the massive sandstones of the northeastern part of the field take on a more shaly aspect toward the southwestern portion (see Plate 2). Taken as a whole, however, all the beds are remarkably uniform, both in matter of thickness and character of the overlying measures, and in the details of the coal seams. The beds which carry partings, bone, rash and the like, were rarely seen without these features in any part of the basin. There was some variation in the actual thickness of the partings, but their location with respect to the coals was always evident.

Structure. For the purpose of simplifying the discussion of the structure, the basin might be divided into three parts, namely, the Fairview on the northeast, the Wattsville in the center, and the Black Ankle on the southwest. These had best be taken up in the order named.

The Fairview division, named from the station on the old East & West railroad and located at the extreme northeast end of the basin, is the only division which presents a good example of the synclinal structure, with a repetition of seams on the eastern side of the trough. This division will be regarded as taking up all of the basin northeast of a line running from Wattsville due southeast across the basin. On the western flank of the Fairview section, the dip is about 14 degrees, a little south of east. There are a few local variations in this dip, but that figure represents the average. In the northern part, there is a depression near the trough which throws the Broken Arrow seam into a narrow outcrop near the center of the basin. This is the seam formerly mapped as the Inman Seam. Southward from this point, in the vicinity of the Seaboard tracks, the overthrust faulting has created an offset in the horizontal beds forming the trough, so that there appears a slight dip southeastward right up to the point where the vertical strata set in. From this sector southward the trough of the basin is very well marked, and three seams of coal were recognized on the eastern side, an occurrence not observed anywhere else in the basin.

The elliptical form of this part of the basin is well exemplified by the outcrop of the Broken Arrow seam, and the lower seams, which swing southward gradually, as the line marking the boundary between Ragland Basin is reached. From this boundary fault the seams outcrop in a regular southwestward direction, with scarcely a bend, except where the depression that gives rise to the remnant of the Broken Arrow causes a slight change, which appears to be local in its nature.

The eastern margins of the basin are marked by pronounced overthrust faults which have piled the whole series of beds included in this report, up against the trough of the fold. In these folded measures which range from 75 to 90 degrees dip, slightly south of east, many of the coal seams were mapped. Near the center of section 32, township 15 south, range 4 east, in the vicinity of Mr. Alverson's house, eight of the seams, from the Lower Chapman to the Marion inclusive, were studied and mapped. It was at this point where a great part of the vertical section given above, was taken. It is not known how far these beds extended, but it is quite apparent that the Marion and Bibby seams show up in the road near old Broken Arrow, as well as in the railroad cuts just to the southwest of this point. These seams were also found near the tipple at Inman, on the Seaboard, in section 21, township 15 south, range 4 east. Whether any more of the seams might be found at these points is a question which will have to be worked out at some later time.

The Wattsville division is characterized by a reversal of the normal strike and dip, both of which are shifted rather abruptly, due to lateral pressure exerted by the overthrust faulting which drove the strata northward and westward. This faulting caused one prominent break, called the Broken Arrow Fault, extending from Broken Arrow in a curved line along the railroad spur, in section 6, township 16 south, range 4 east. This fault has both vertical and lateral displacement, with the maximum in each case

Quite a few other pits have been opened in the region about Wattsville, but the amount of coal taken from them has always been small, and largely by stripping. At present, the only large mine (see Plate 1-B) operated in the area is that started by the Ragland Coal Company in the southeast part of the SW¼ of the NE¼ of section 36, township 15 south, range 3 east, where a main slope was driven for 960′ along the dip, with several laterals, the second entry on the right being driven out 1,000′, all roughly parallel to the strike. It is quite evident that the Ragland Coal Company was anxious to prove the good working qualities of the seam, the even character of the coal, and to disprove the theory that the area was all broken up with faults. The coal taken from this mine was hauled by wagons at 45c per ton to Wattsville, about a mile away, where it was loaded and shipped. This procedure proved to be a very expensive one, as the Ragland Coal Company probably anticipated, and the mine was temporarily closed to await more favorable railroad facilities.

The old Black Ankle pits, located about section 15, township 16 south, range 3 east, were the scene of some mining activity along about Civil War days. The coal was taken from the Upper Chapman or Ragland seam, about the turn at number 20.

Openings were also made near the Black Ankle pits, at the old Bibby place in section 14, township 16 south, range 3 east, probably near location 7 and 8 on the Bibby seam. Also near the old Bibby place are located the old Marion Tomason pits, on what is now known as the Marion seam, where quite a bit of coal was removed by stripping. The dip at this point was about 2 degrees, slightly south of west. The coal from all these Black Ankle division pits was used principally by blacksmiths, who regarded it as very high quality product. In those days good smith coal was diligently sought after, and when found, was regarded as being suitable for any purpose desired.

DESCRIPTION OF COAL SEAMS

Hammond. This is the thickest and best seam of coal in the Wattsville Basin, having a thickness, exclusive of partings, of more than 5 feet of excellent lump coal. The seam is overlain by shales, which make a fair roof. In the mine (see Plate 3) which is being operated at the present time, no trouble was being experi-

and occurring at the southern terminus. This fault plays out before the lower seams on the western margin are reached, with the Brown seam being the lowest one affected. Another small fault which occurs in this area was observed on section 1, township 16 south, range 3 east, where a very slight lateral displacement was noted. This fault probably does not affect the Marion seam, and caused only a slight offset in the Broken Arrow. The vertical displacement of the Broken Arrow fault, where it juts up against the vertical measures, is estimated at 230 feet and might even be greater than that. The reversal of the dip to the southward and even southwestward along this line, accounts for about 200 feet of additional strata which make up the top of the series in the Black Ankle Basin.

The lower seams are apparently not broken by the faults, but they are turned sharply to the westward, and show a dip of about 30 degrees southward.

It is quite possible that other faults occur in this region, but none of them show any appreciable displacement, either lateral or vertical. It is said that one of the mines operated near the center of section 1, township 16 south, range 3 east, actually ran up against fault planes, but none of these showed up in the outcrops examined and are therefore thought to be very small.

Quite a considerable number of outcrops and openings was mapped on the lower seams along the western margin of the basin, and any break in that section would have been spotted easily. Thus, it is with reasonable certainty that the writer states that no faulting has affected these beds. The sharp swerve made by the seams at that point suggests that the beds were far enough away from the lateral pressure and swinging motion to safely withstand displacement.

It might be well to call attention especially to the 4 degree south dip of the beds along the railroad in the NW¼ of the NW¼ of section 6, township 16 south, range 4 east. This shift is very obvious, and is due to the depression occurring to the southward in the Black Ankle Basin.

Thus we are brought to the Black Ankle division, which carries about 550 feet more strata than the rest of the basin. This brings in the Coal Branch and Hammond seams, which are not found elsewhere in the area. This part of the basin has a roughly elliptical shape, but differs from that of the Fairview section by having a sharply curved trough. This curving is, of course, governed by the degree of intensity of the lateral pressure, as is expressed by the pinching out of the measures in the so-called vertical zone to the east of the basin.

The dip on the western margin of this part of the basin is about that of the Fairview division, or about 14 degrees. Of course, near the vertical measures, the dip is pronounced. Nearer the center of the basin and at the turn on the southern end, the dip decreases rapidly, often not exceeding 2 degrees. Within the vertical area, the strata usually stand at about 90 degrees.

This area carries the maximum thickness of strata making up this basin, or about 1,700 feet. Gibson calculated the vertical distance between the Second Conglomerate which forms the western rim of the Coosa Coal Field, and the Fourth Conglomerate which forms the inner rim, at about 5,500 feet, which appears to be the maximum thickness for the entire field.

This division shows the trough of the fold, which terminates against the minor fault just at the northwest corner of section 7, township 16 south, range 4 east. The dip of the strata enclosing the Hammond seam in the northeastern part of section 12, township 16 south, range 3 east, is about 15 degrees, which is abnormally high for beds so near the trough. This pitch is regarded as a direct result of the terrific overthrust faulting and subsequent depression which occurred just to the east of this locality.

MINING

The discovery of coal in the Coal City Basin is attributed to a party of hunters plying their trade in the vicinity of Fairview, an old station on the East & West railway. This seam was thus christened the Fairview Seam, and has since been called the Big Seam. The exact date of this discovery is not known, but it is thought to have been in 1845. Some mining was done at this place, but on a very small scale. Near Fairview on the Higginbotham farm, was discovered the seam that bears his name. A few hundred yards northwest of Fairview on the H. Chapman place, the seam which now bears the name Upper Chapman, was cut.

A few years before the Civil War, the Fairview Mining Company was organized and an opening made on the Fairview seam about a half a mile south of the Fairview station. After a period of several years of very successful operation, their affairs became involved in some way or other and operations were closed.

The old Inman mines must have been opened about 1855, although there are no records at hand which provide the exact date. These mines had up-to-date machinery for mining, screening and loading the coal into cars, and operated very profitably for many years. They were located in the southeast corner of section 16, township 15 south, range 4 east, or thereabouts, and shipments were made from the Inman Junction, on the old East & West railroad. This mining was done on Broken Arrow seam. Operation at this place has been carried on spasmodically ever since that time.

Prof. Tuomey visited the Wattsville division in 1847, and reported the coals of that region as being very promising, and of excellent quality. A good bit of mining was done in this area prior to the Civil War. The output was greatly increased between 1861 and 1865, when a considerable amount of coal was taken from the Broken Arrow seam and sent to the Confederate States arsenal at Selma.

Prior to the Civil War mining was done on three seams, namely, the Brown, Bibby and Broken Arrow. The Hudson mine, located in the northwest corner of section 6, township 16 south, range 4 east, was probably driven in on the Brown seam, perpendicular to the strike and so operated that it was self-draining. Now the old works are caved in and no very accurate information concerning this mine can be obtained. The Gould opening was probably made on the Bibby seam, near the Hudson mine, and was operated for several years. The other opening was made on the Broken Arrow seam, but little coal was removed at that time.

After the Civil War closed, it was quite a few years before mining was resumed in this area. In 1880, when the Georgia Pacific Railroad was being built, there was a demand for coal which was supplied by D. B. Moore from a mine opened south of the old town of Coal City, probably on the Coal Branch seam.

In 1882 the Broken Arrow Coal Company was formed and began operations on the Broken Arrow seam, doing a good bit of mining over a period of several years. This company erected a number of coke ovens, so arranged as to be loaded directly by tram cars from the mines. The main slope of this mine was said to have run against a fault, the displacement of which was unknown (probably the one mapped in section 1, township 16 south, range 3 east). The company became discouraged at this unexpected turn of affairs, and operations were finally abandoned.

About 1914 this mine was reopened by a Japanese company, which was making pig-iron at Talladega. This property has since become involved in court proceedings which caused temporary suspension. The equipment is in good shape, and plans are laid for resumption as soon as the litigation troubles are settled.

About 1886 the property of the Broken Arrow Coal Company was sold to the Eureka Company, which decided to open up a new place rather than to try to clean out the old mine. Accordingly they sank a slope on the Marion seam, then called the Eureka seam. This mine was actively operated for several years, when the main slope was driven out at the surface, due to the southerly dip at that place. This was also an unexpected turn of affairs, and little more mining was done by the company. This opening appears to have been very close to the number 6 opening mapped on that seam in section 1, township 16 south, range 3 east.

The Coal City Mining Company next acquired this property about 1890, and began operations on the Coal Branch (Coal City) seam near the old Moore opening, where they carried on a prosperous business for many years. This seam was capped by a three-floor ledge of bituminous shale which had to be removed in mining. This increased the costs considerably. However, during the years which followed, this company removed a great amount of coal from both slopes which they drove in. At present, there are great piles of smouldering shale outside these slopes which give mute evidence to the fact that the mining here was really done on a large scale. The Coal City Mining Company's slope number 1 ran against a fault, which is the same one that gave trouble in the mines on the lower seam. This company has long since ceased operation, and the slopes have so caved in that one can hardly tell where they were located.

The Hammond seam was opened about 1850-60 and some coal taken out by stripping. These old pits were located near the south line of section 1, township 16 south, range 3 east, at the spot where Mr. W. T. Brown has recently sunk a mine which gives promise of being one of the best in the entire area.

Quite a few other pits have been opened in the region about Wattsville, but the amount of coal taken from them has always been small, and largely by stripping. At present, the only large mine (see Plate 1-B) operated in the area is that started by the Ragland Coal Company in the southeast part of the SW¼ of the NE¼ of section 36, township 15 south, range 3 east, where a main slope was driven for 960′ along the dip, with several laterals, the second entry on the right being driven out 1,000′, all roughly parallel to the strike. It is quite evident that the Ragland Coal Company was anxious to prove the good working qualities of the seam, the even character of the coal, and to disprove the theory that the area was all broken up with faults. The coal taken from this mine was hauled by wagons at 45c per ton to Wattsville, about a mile away, where it was loaded and shipped. This procedure proved to be a very expensive one, as the Ragland Coal Company probably anticipated, and the mine was temporarily closed to await more favorable railroad facilities.

The old Black Ankle pits, located about section 15, township 16 south, range 3 east, were the scene of some mining activity along about Civil War days. The coal was taken from the Upper Chapman or Ragland seam, about the turn at number 20.

Openings were also made near the Black Ankle pits, at the old Bibby place in section 14, township 16 south, range 3 east, probably near location 7 and 8 on the Bibby seam. Also near the old Bibby place are located the old Marion Tomason pits, on what is now known as the Marion seam, where quite a bit of coal was removed by stripping. The dip at this point was about 2 degrees, slightly south of west. The coal from all these Black Ankle division pits was used principally by blacksmiths, who regarded it as very high quality product. In those days good smith coal was diligently sought after, and when found, was regarded as being suitable for any purpose desired.

Description of Coal Seams

Hammond. This is the thickest and best seam of coal in the Wattsville Basin, having a thickness, exclusive of partings, of more than 5 feet of excellent lump coal. The seam is overlain by shales, which make a fair roof. In the mine (see Plate 3) which is being operated at the present time, no trouble was being experienced with either roof or floor. The detailed measurement of the seam at the end of the main slope (150′ deep) is as follows:

Top	Black to dark gray bituminous shale.
0′ ½″	Rash and bone.
2′ 2″	Coal, hard lump variety.
1′ 4″	Parting of slate which is gobbed in the mine.
1′ 8″	Coal, as above.
0′ 6″	Slate, gobbed in the mine.
1′ 10″	Coal, somewhat less lumpy than the above, but is high grade coal.
Bottom	Shale, very much as above.

An analysis of a sample of coal taken at this point, according to the methods laid down by the Bureau of Mines, is as follows:

Moisture in mine sample, 7.4%; analysis of air dried sample

Moisture	.83
Volatile	30.95
Fixed Carbon	58.28
Ash	9.94
Sulphur	.98

(By Dr. R. S. Hodges, Staff Chemist, University, Alabama, January 27, 1925.)

There is no doubt of the fine quality of this coal, and the only drawback to its development is the fact that the reserves are meager. This coal appears peculiarly adapted to grate and steam uses and should find a ready market.

The Hammond seam was first opened by a man of that name. During recent years the name was changed to the Dirty Dozen seam, presumably alluding to the workmen who were operating a mine at number 6 opening.

The coal from this seam is easily mined. The men dig out the top layer, and load it on the cars. Then the top parting is broken off and gobbed. The middle coal is next loaded, when the lower parting is gobbed, which leaves the bottom seam on the solid floor from which it is easily extracted. The roof is high enough overhead that the men have no trouble at all in moving about the mine. Another good point about this seam is the comparatively small amount of water that is entering the mine from the upper levels. It is possible that the flow may be increased with depth, but that remains to be seen.

It should be mentioned in passing that there is a shale seam about 20 feet below the Hammond, called the Brewer seam, which upon first glance, appears to be a splendid seam of coal. When the walls are dug into, however, quite a different impression is had. The seam is about 6 feet thick, with alternating layers of coal and bituminous shale, none of the layers being more than 6 inches thick.

PLATE

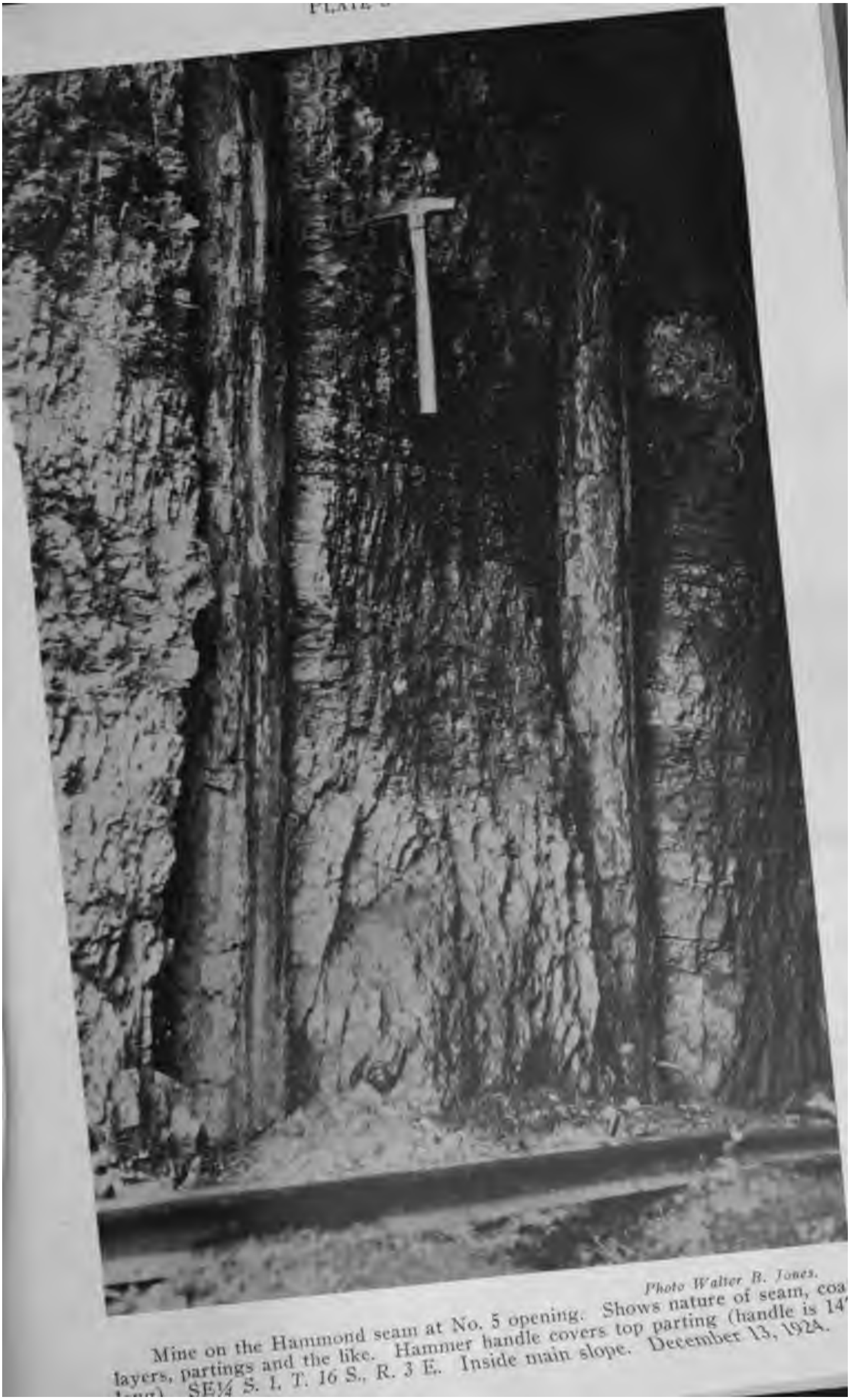


Photo Walter B. Jones.

Mine on the Hammond seam at No. 5 opening. Shows nature of seam, coa layers, partings and the like. Hammer handle covers top parting (handle is 14' long). SE¼ S. 1, T. 16 S., R. 3 E. Inside main slope. December 13, 1924.

This mine could be operated most advantageously along with mines on the other seams, and the coal used for better mixtures, or to supply demands for which the other coals in the area are not suited.

The list of outcrops and openings on the Hammond is as follows:

1. Outcrop near road in SE¼ of SW¼ S 6 T 16 S R 4 E.
2. Old mine now entirely caved in near township line in SE¼ of SE½ S 1 T 16 S R 3 E.
3. Outcrop near center of SE¼ of SE¼ S 1 T 16 S R 3 E.
4. Outcrop in SE corner of SW¼ of SE¼ S 1 T 16 S R 3 E.
5. 26" coal, 16" clay, 15" coal, 6" clay, 22" coal, in SE corner of SW¼ of SE¼ S 1 T 16 S R 3 E.
   Mine now in operation, main shaft 150', several lateral rooms, gobbing clay partings.
6. Old mine now filled with water, in NW¼ of NE¼ S 12 T 16 S R 3 E.

Coal Branch. The Coal Branch seam (formerly known as the Coal City seam, from the Coal City Mining Company which first opened it)is a high class seam, reported by Gibson to be 4 feet thick and of excellent quality. This seam was not measured by the writer since both the old mine openings were filled with water.

It was reported that the roof of this mine was very good, but that there was a 3 foot layer of bituminous shale just above the coal which had to be removed in mining. Why this material was not gobbed is not known. Anyway, removing this material practically doubled the hoisting expenses, and made the dump unnecessarily large. One advantageous feature of this project, however, is that it afforded the miners plenty of room to work in.

In 1893 this mine produced 50,000 tons of coal, part of which was used in the coke ovens near the tipple. The following analyses by Dr. J. M. Pickel of the University of Alabama, is of interest:

Moisture	1.38
Volatile	35.96
Fixed Carbon	58.80
Ash	5.26
Coke	63.56
Sulphur	0.53

The low sulphur content made the coal well adapted for forge, furnace, and foundry work. Probably this coal would prove to be good steam coal, for it has the requisite percentage of lumps.

Gibson included in his report many testimonials from railway officials who had been using coal from this seam, relating to its super-excellence for steam purposes.

It is not known just how much water invaded the mines on this seam, but from the way that they appear at the present time, there was likely a plentiful supply.

This seam is confined to the southwestern portion of the basin, and therefore the reserves are limited. The high quality of the coal should encourage its immediate development, if a spur could be run into the area to handle the output. Such a spur could easily serve mines on the Broken Arrow, Coal Branch and Hammond seams.

The name of the seam is contributed by the Coal Branch Creek which runs along its outcrop for more than a mile.

The list of openings on the Coal Branch is as follows:

1. **48" (Gibson) old mine filled with water in NE corner of SW¼ of SE¼ S 1 T 16 S R 3 E.**
2. **48" (Gibson) old mine filled with water in SW¼ of SE½ S 1 T 16 S R 3 E.**

Broken Arrow. This is a very good seam of coal, about 36 inches thick, average of 11 outcrops measured. The Broken Arrow Coal Company started mining on this seam in 1882, and an appreciable amount of coal was removed, some sold directly and some coked at the mines. No record of the mining was kept, however, so that the total amount taken can not be estimated. It is known, however, that the industry thrived for several years. The coal is a very good quality, and is thick enough to be mined profitably under present conditions. The reserve supply of coal in this seam is not as high as in the lower seams, but there appears no reason why this one should not be exploited along with the general scheme for the field. Other mines operating on the Broken Arrow are those at Inman Switch, which are gradually exhausting the supplies at that place.

The coal is a good quality, high percentage lump, and should find a ready market. The coal cokes well, according to reports from the old workings in Broken Arrow.

The usual amount of water is present in the measures which enclose this seam. Although there are no partings in the Broken Arrow, washing is recommended. Some of the outcrops show a few inches of bone at the top, and it is impracticable for miners to prevent some of this material from getting into the coal. It is also believed that a good part of the sulphur is carried in the bone and rash at the top of the seam, and if this is the case, most of the objectionable constituents will be removed during the washing process.

There are no analyses available to show the relative values of the various components.

The list of outcrops and openings in the Broken Arrow is as follows:

1. 30" in SE¼ of SE¼ S 16 T 15 S R 4 E—old mine.
2. 30" in SE¼ of SE¼ S 16 T 15 S R 4 E—old Inman Mine.
3. 32" in SE¼ of SE¼ 16 T 15 S R 4 E—present Inman Mine, 300′ deep, more or or less.
4. 30" in NW corner of NE¼ of NE¼ S 21 T 15 S R 4 E—old mine.
5. 40" near N line in NW¼ of SE¼ S 1 T 16 S R 3 E.
6. 28" in NE¼ of SW¼ S 1 T 16 S R 3 E.
7. 28" in NE¼ of SW¼ S 1 T 16 S R 3 E—drift mine.
8. 28" in SE¼ of SW¼ S 1 T 16 S R 3 E—old mine, main shaft, 400′ deep, one lateral each direction, along strike.
9. Outcrop in SW¼ of NW¼ S 12 T 16 S R 3 E.
10. 42" near S line in SW¼ of NW¼ S 12 T 16 S R 3 E.
11. Outcrop near E line in NE¼ of SE¼ S 11 T 16 S R 3 E.
12. 86" in SE corner of SE¼ of SE¼ S 11 T 16 S R 3 E.

12A. Boring (records lost) in SE corner of SE¼ of SE¼ S 11 T 16 S R 3 E.

13. 86" in SW corner of NW¼ of SW¼ S 14 T 16 S R 3 E.
14. Outcrop in NE¼ of NW¼ S 23 T 16 S R 3 E.

Marion. The Marion seam is a very good one, averaging almost 30 inches of clean coal, from 7 pits. The seam is very uniform, both in thickness and the quality of its coals. A good bit of coal was mined from numbers 7 and 8 openings, and number 20 is the site of a drift mine about 20 feet deep. Some coal was taken many years ago from the old Marion Tomason pits in the Black Ankle country, by stripping, finding its way into the market as smithing coal, for which it was well adapted. This coal was very uniform in texture, harder than some of the Wattsville Basin coals, coked easily in the forges and had enough volatiles to be free-burning with plenty of heat.

This seam is under-lain and overlain by shales which makes mining a little more tedious than would be desired. However, in the mines that were opened up near Wattsville, there was little tendency for the roof to cave, so that timbering was not such a discouraging factor as might have been expected. No parting has ever been noted in this seam, and no trouble with mining the coal has yet been experienced. The mined product is the small lump to slack variety, somewhat similar to that of the Bibby seam.

The Marion seam was examined in a number of places, on both sides of the basin, and in the vertical measures to the east of the basin. Unfortunately many of the outcrops were so filled with water and sediment that measurements could not be taken with any degree of accuracy. However, the outcrops that were measured were sufficiently well distributed to give a good average.

There were no analyses available for this coal, but it is considered by the writer to be of a good merchantable grade. It appears at sight to be more suited for coke and steam than for grate purposes.

The name was derived from the Marion Tomason pits, where the seam was first opened.

The list of outcrops and opening on the Marion is as follows:

1. Outcrop in SE¼ of SE¼ S 16 T 15 S R 4 E.
2. Outcrop in SE¼ of SE¼ S 16 T 15 S R 4 E.
3. 22" in railroad cut, extreme northwest corner of S 28 T 15 S R 4 E.
4. Outcrop in NW¼ of NW¼ S 32 T 15 S R 4 E.
5. Outcrop in SE¼ of NW¼ S 6 T 16 S R 4 E.
6. Outcrop in road, center of SW¼ of NE¼ S 1 T 16 S R 3 E.
7. Outcrop in SE corner of SE¼ of NW¼ S 1 T 16 S R 3 E, old mine.
8. 30" in SE corner of NW¼ of SW¼ S 1 T 16 S R 3 E, old mine.
9. 30" near N line of SW¼ of SW¼ S 1 T 16 S R 3 E.
10. Outcrop in NE corner of SE¼ of NE¼ S 11 T 16 S R 3 E.
11. Outcrop in SW¼ of NE¼ S 14 T 16 S R 3 E.
12. 30" in NE¼ of SW¼ S 14 T 16 S R 3 E.
13. 32" near center of SW¼ of NW¼ S 23 T 16 S R 3 E.

13A. Borings (records lost) near W line in SW¼ of NW¼ S 23 T 16 S R 3 E.

14. Outcrop in railroad in SW corner of NW¼ of NW¼ S 7 T 16 S R 4 E.
15. Outcrop in road in SE¼ of SW¼ S 6 T 16 S R 4 E.
16. Outcrop near center of SW¼ of SW¼ S 32 T 15 S R 4 E.
17. Outcrop in SE¼ of NW¼ S 32 T 15 S R 4 E.
18. Outcrop near NE corner of SE¼ of NW¼ S 32 T 15 S R 4 E.
19. Outcrop in railroad cut in SE¼ of SW¼ S 21 T 15 S R 4 E.
20. 30" in SW¼ of NE¼ S 6 T 16 S R 4 E. Drift mine 20' deep.
21. 30" in NE¼ of NE¼ S 6 T 16 S R 4 E.
22. Outcrop in NE¼ of NE S 6 T 16 S R 4 E.
23. Outcrop in NE¼ of SW¼ S 32 T 15 S R 4 E.

Bibby. The Bibby seam shows an average thickness of 24 inches for 10 outcrops, with a maximum reported as 30 inches. This is too thin to be of any great commercial importance at the present time. The coal appears to be a very good grade and the seam may become of value in a few years.

This seam was first cut on the old Bibby place in section 14, township 16 south, range 3 east, and some coal taken out of pits in the immediate vicinity, the blacksmiths reporting that it was excellent. The coal from this seam resembles that from the Lower Chapman seam, that is small lump or slack variety.

There is a small drift mine on this seam at number 17 opening. Mining appears to be rather easy, and the over-lying flagsandstones make a very good roof. An abundance of water, which is so characteristic of the whole basin, is present in this seam also.

The list of outcrops and openings on the Bibby is as follows:

1. Outcrop in SW corner of NE¼ of SE¼ S 16 T 15 S R 4E.
2. Outcrop in NE corner of SW½ of SE¼ S 16 T 15 S R 4 E.
3. 22" in railroad cut in NE¼ of NE¼ S 29 T 15 S R 4 E.
4. 24" in SW¼ of SW¼ S 29 T 15 S R 4 E.
5. Outcrop in SW¼ of SW¼ S 14 T 16 S R 3 E.
5A. 20" about center of SE¼ of NW¼ S 14 T 16 S R 3 E.
6. 24" in SE corner of NE¼ of NW¼ S 14 T 16 S R 3 E.
6A. Boring (records lost) in SE¼ of NW¼ S 14 T 16 S R 3 E.
7. 20" near center of SE¼ of NW¼ S 14 T 16 S R 3 E.
8. Outcrop in NE¼ of SW¼ S 14 T 16 S R 3 E.
8A. 24" in SE part of NW¼ of SW¼ S 14 T 16 S R 3 E.
9. Outcrop in NW¼ of SW¼ S 14 T 16 S R 3 E.
10. 20" in NW part of NW¼ of NW¼ S 23 T 16 S R 3 E.
11. Outcrop in SE¼ of NE¼ S 22 T 16 S R 3 E.
11A. 24" in NE part of SW¼ of NW¼ S 23 T 16 S R 3 E.
12. Outcrop in railroad in NW¼ of NW¼ S 7 T 16 S R 4 E.
13. Outcrop in road in SE¼ of SW¼ S 6 T 16 S R 4 E.
14. Outcrop in NE part of SE¼ of NW¼ S 32 T 15 S R 4 E.
15. Outcrop in railroad in SE part of SE¼ of SW¼ S 21 T 15 S R 4 E.
16. Outcrop in SWP of NEP S 6 T 16 S R 4 E.
17. 30" in SW¼ of NE¼ S 6 T 16 S R 4 E. Drift mine 30' deep.
18. Outcrop in NE¼ of NE¼ S 6 T 16 S R 4 E.
19. 28" in NW¼ of SW¼ S 32 T 15 S R 4 E.

Brown. This seam is variable, ranging in thickness from 22 to 43 inches. It differs from some of the other beds, however, in that no slate partings show up where the seam thickens. The average thickness for 15 pits is 32 inches. This seam is underlain by a layer of fire-clay, bluish-gray to steel-gray in color, and about 6 feet thick. The overlying measures are predominantly clays and shales, with some sandy phases showing up in the northern part of the basin. A detail section of the seam taken at number 7 is as follows:

Top —Shale, thin-bedded, dark blue to black.
0' 7"—Slack coal, with stringers of bone and rash.
1' 6"—Good clean coal, lump variety.
1' 3"—Clay, light blue, stringers of iron stain.
1' 6"—Clay, bluish to steel-gray, hard, comparatively free from grit.
3' 0"—Light-blue clay.
Bottom—Shale.

Number 6 opening contributed the following section:

Top —Shale and soil, with pebbles.
0' 4"—Coal, with a bit of blue clay and shale intermixed.
0' 6"—Blue clay with a little grit.
0' 6"—Coal, slack with some dirt and rash.
1' 8"—Clean coal, lump character.
6' 0"—Clays, blue to gray.
Bottom—Shales.

Both of these sections were obtained from the weathered outcrops and it is quite likely that the part of the seam which shows rash and clay will change to good coal when the zone of weathering has been passed. This may account for the fact that some of the seam cuttings showed so much more coal than others.

As a whole the Brown seam is better than the Lower Chapman, the coal being as thick or thicker, and a good lump variety. The reserves are necessarily much less (of the Brown) than those of the Lower Chapman.

The only available analysis of the Brown coal was made from a sample from number 12 opening, collected in August, 1924, and analyzed by Dr. Hodges, Staff Chemist, which shows the following results:

Moisture	.88
Volatile	30.92
Fixed Carbon	62.30
Ash	5.90
Sulphur	2.11

The coal from this seam is a good merchantable grade suitable for steam or grate uses.

The list of outcrops and openings on the Brown is as follows:

1. Outcrop in SE¼ of SE¼ S 10 T 15 S R 4 E.
2. 24" in SW¼ of SE¼ S 10 T 15 S R 4 E—drift mine.
3. 22" in NE¼ of SW¼ S 16 T 16 S R 4 E—small drift mine.
4. Outcrop in railroad cut in NW¼ of NE¼ S 29 T 15 S R 4 E.
5. 28" in NE corner of SE¼ of NW¼ S 29 T 15 S R 4 E.
5A. 43" about center of SE¼ of NW¼ S 14 T 16 S R 3 E.
6. 26" in NW part of NE¼ of SW¼ S 29 T 15 S R 4 E.
7. 25" in SW¼ of SW¼ S 29 T 15 S R 4 E.
7A. 30" in SE corner of SE¼ of SE¼ S 2 T 16 S R 3 E.
8. 28" in SE corner of SE¼ of SW¼ S 11 T 16 S R 3 E.
8A. 42" near E line in NW¼ of SW¼ S 15 T 16 S R 3 E.
9. Outcrop in NE¼ of SW¼ S 14 T 16 S R 3 E.
10. 42" in SW¼ of SW¼ S 14 T 16 S R 3 E.
11. 26" in SE corner of SW¼ of NE¼ S 32 T 16 S R 3 E.
12. 42" in SE corner of NW¼ of SW¼ S 32 T 15 S R 4 E.
13. 28" in NE corner of SE¼ of NW¼ S 32 T 15 S R 4 E.
14. 30" in SW corner of SE¼ of NE¼ S 6 T 16 S R 4 E drift mine 100' deep.
15. Outcrop in NE¼ of NE¼ S 6 T 16 S R 4 E.
16. Outcrop in NE¼ of NE¼ S 6 T 16 S R 4 E.
17. 42" in SW¼ of SW¼ S 32 T 15 S R 4 E.

Gann or Clean Seam. This is a very nice little seam of coal, usually averaging nearly 2 feet in thickness, and a nice lump variety which would find extensive usage for grate or furnace coal. This seam has been tapped at several places by people who were hunting for something to burn in their grates. The coal is very clean, and lumpy throughout its entire thickness, and shows no variations at any place in the field. The coal occurs within shale measures, top and bottom, so that efforts to work the seam would have to be accompanied by the usual soft roof timbering. No doubt, there is plenty of water in these beds also, even though they are shales, and the extreme thinness of the seam would likely require the removal of some lower or upper measures in order to acquire sufficient working space. This would add cost to the loading and hoisting, unless the excess could be gobbed, in which case the only extra expense would be the handling within the mine.

The outcrop of this seam invariably follows a valley or ravine just to the east of the ridge which overlies the Fairview seam, made up of the massive-sandstones which cover that member. The Higginbotham seam is usually at the western edge of the valley while the Gann occurs without fail almost, in the bottom. This is one of the most characteristic features of the entire group and is really startling in its persistence.

A small drift mine has been opened at number 4 on the Gann seam, where several cars of coal were mined, the shaft penetrating about 30 feet along the dip. The miners at work in this opening say that the coal is unusually easy to mine, and the material piled up outside the entrance was certainly nice to look at. From reports that came in from time to time from people about the country who had used this coal, it must burn admirably in the grate.

The list of outcrops and openings on the Gann or Clean seam is as follows:

1. Outcrop near Fairview in NE corner of NW¼ of SE¼ S 10 T 15 S R 4 E.
2. 24″ near E line in NE¼ of SW¼ S 10 T 15 S R 4 E.
3. 20″ near N line in NE¼ of NE¼ S 30 T 15 S R 4 E.
4. 20″ in NE part of SE¼ of NE¼ S 36 T 15 S R 3 E—drift mine 30′ deep.
5. 15″ near S line of SE¼ of NE¼ S 36 T 15 S R 3 E.
6. 18″ bored with test auger in NE part of SW¼ of SE¼ S 36 T 15 S R 3 E.
7. 20″ in NE corner of NW¼ of NE¼ S 1 T 16 S R 3 E.
8. Outcrop in road in NE¼ of NW¼ S 1 T 16 S R 3 E.
9. 24″ in SE corner of NE¼ of NW¼ S 11 T 16 S R 3 E.
9A. 24″ in SW corner of SE¼ of NW¼ S 11 T 16 S R 3 E.
10. 24″ in SE¼ of NW¼ S 11 T 16 S R 3 E.
11. Outcrop in SE corner of SE¼ of NE¼ S 15 T 16 S R 3 E.
12. Outcrop in NW¼ of NE¼ S 22 T 16 S R 3 E.
13. 24″ near N line in SE¼ of SW¼ S 22 T 16 S R 3 E.
14. Outcrop in SE¼ of NE¼ S 32 T 15 S R 4 E.

Higginbotham. This seam shows an average thickness of about 30 inches, made up of a fair grade of small lump coal that might be used to advantage for steam purposes. There are no analyses available for these coals, but they are thought to be very similar to the general run of the Fairview seam. The seam does not have a parting, from evidence gathered from almost a dozen good outcrops, but the shales (see Plate 1-A) which make up the roof might give trouble. The seam appears to be very uniform in thickness and character, and would furnish a better prospect than the Lower Chapman.

The name was derived from the first opening which was made on the Higginbotham place, near Fairview station, some time prior to 1850.

The outcrops and openings on the Higginbotham are as follows:

1. Outcrop near Fairview, NE corner of NW¼ of SE¼ S 10 T 15 S R 4 E.
2. 28" in NW corner of NE¼ of NE¼ S 30 T 15 S R 4 E.
3. 20" bored with test auger in SE corner of SE¼ of NW¼ S 30 T 15 S R 4 E.
4. 30" bored with test auger in NE portion of SE¼ of NE¼ S 36 T 15 S R 3 E.
5. 28" in SE¼ of NE¼ S 36 T 15 S R 3 E.
6. Outcrop bored with test auger in SW¼ of SE¼ S 36 T 15 S R 3 E. in railroad cut.
7. 28" in SW corner of SW¼ of SE¼ S 36 T 15 S R 3 E.
8. Outcrop near E line of NE¼ of NW¼ S 1 T 16 S R 3 E.
9. 32" in SE part of NE¼ of NW¼ S 11 T 16 S R 3 E.
10. Outcrop in NW part of NE¼ of SW¼ S 11 T 16 S R 3 E.
11. Outcrop near center of SE¼ of NW¼ S 15 T 16 S R 3 E.
12. 30" near center of NE¼ of NW¼ S 22 T 16 S R 3 E.
13. 32" in old well in NE corner of SW¼ of SW¼ S 22 T 16 S R 3 E.
14. 32" near W line in SE¼ of SW¼ S 22 T 16 S R 3 E. in forks of road.
15. Outcrop in SW¼ of NE¼ S 32 T 15 S R 4 E.

Fairview or Big Seam. This is by far the most promising seam in the group, in spite of the heavy clay parting which occurs near the center of the seam. This parting ranges from 4 to 10 inches, usually, but locally has been reported much thicker. The seam carries in addition to the clay, from 36 to 50 inches of coal, with 40 inches a conservative estimate of the average (see Plate 4). The seam is overlain by a heavy bed of massive sandstone which affords excellent roof conditions, and underlain by thin-bedded sandstones and shaly sandstone giving a clean floor. The coal itself is shown by analyses, of which there are many, to be a comparatively low ash-high carbon coal, with a high percentage of sulphur. Mr. H. A. Turner, in making an investigation of the Fairview coals in 1922 for the Seaboard, expressed the opinion that most of the sulphur volatilized in the furnace since the ashes drawn from the boilers did not show any special tendency to clinker. If this is the case, it is quite likely that most of the sulphur content would be removed by washing.

The actual mining of the seam (see Plate 1-B, 5 and 6) as practiced in the mine of the Ragland Coal Company at number 10 opening, is entirely practical. The clay or slate parting is removed first and gobbed. Then the top layer of coal which adheres tenaciously to the roof, is popped down and loaded. After this the bottom layer is shot and loaded directly from a comparatively clean floor. The coal is hoisted out of the main opening which is 10 feet wide and tracked with 40 pound rails, the equipment being capable of handling about 500 tons a day. This amount of coal was never taken out, however, on account of the lack of rail facilities for marketing.

PLATE 4

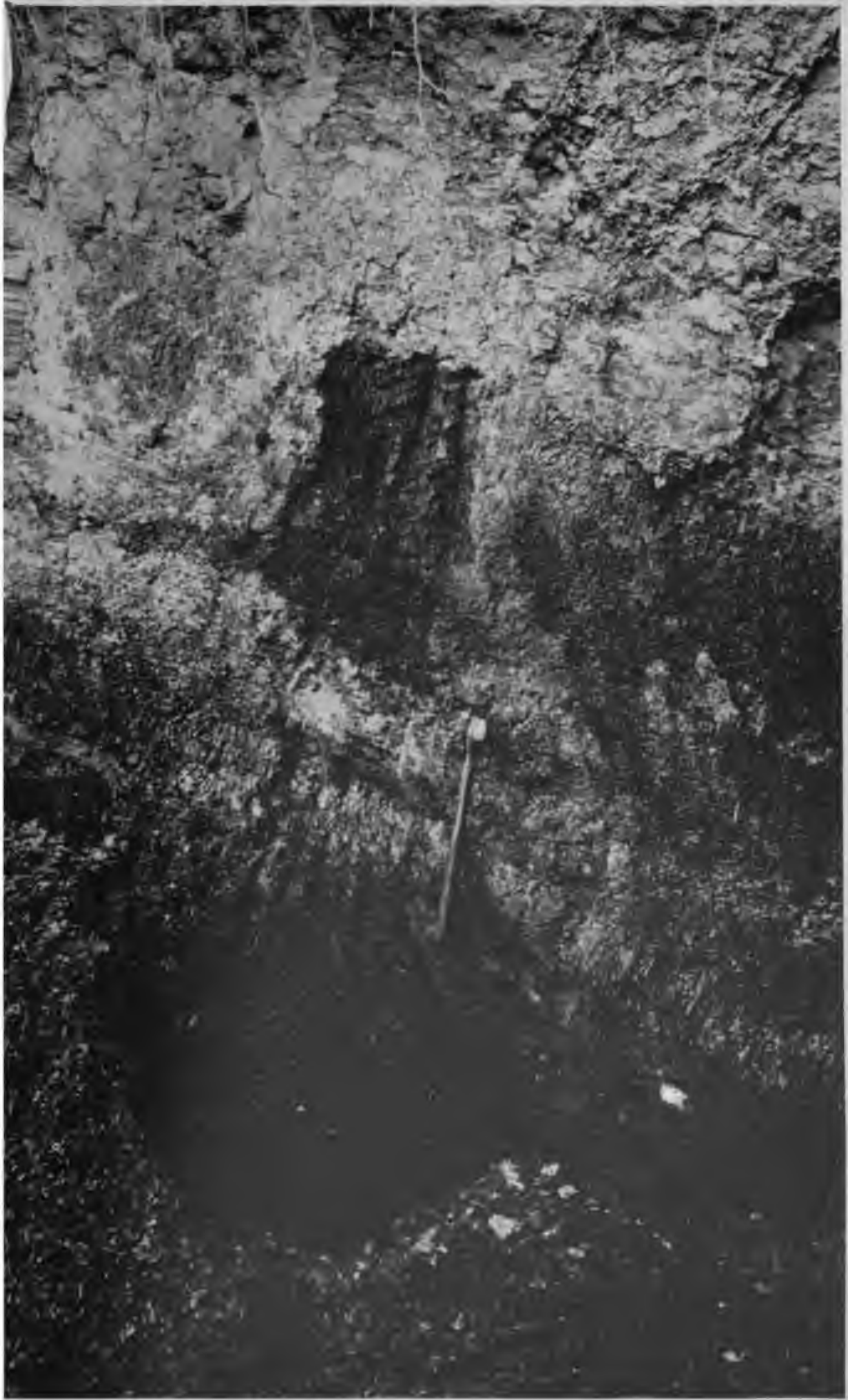


Photo by Walter B. Jones.

Fairview seam at No. 13 opening; total thickness 55", including clay parting 7" thick (covered by hammer handle). SW¼, S. 36, T. 15 S., R. 3 E. December 12, 1924.

PLATE 5

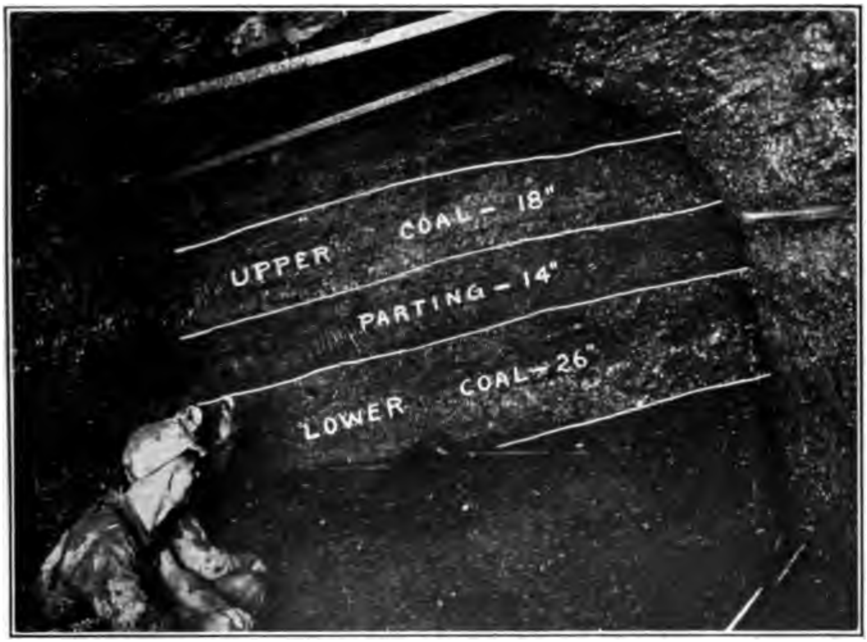


Photo B'ham View Co., 1924.

A. Face of third right entry about 400′ from the slope, leading west. Mines operated by the Ragland Coal Co., Wattsville, Alabama, on the Fairview or Big Seam.

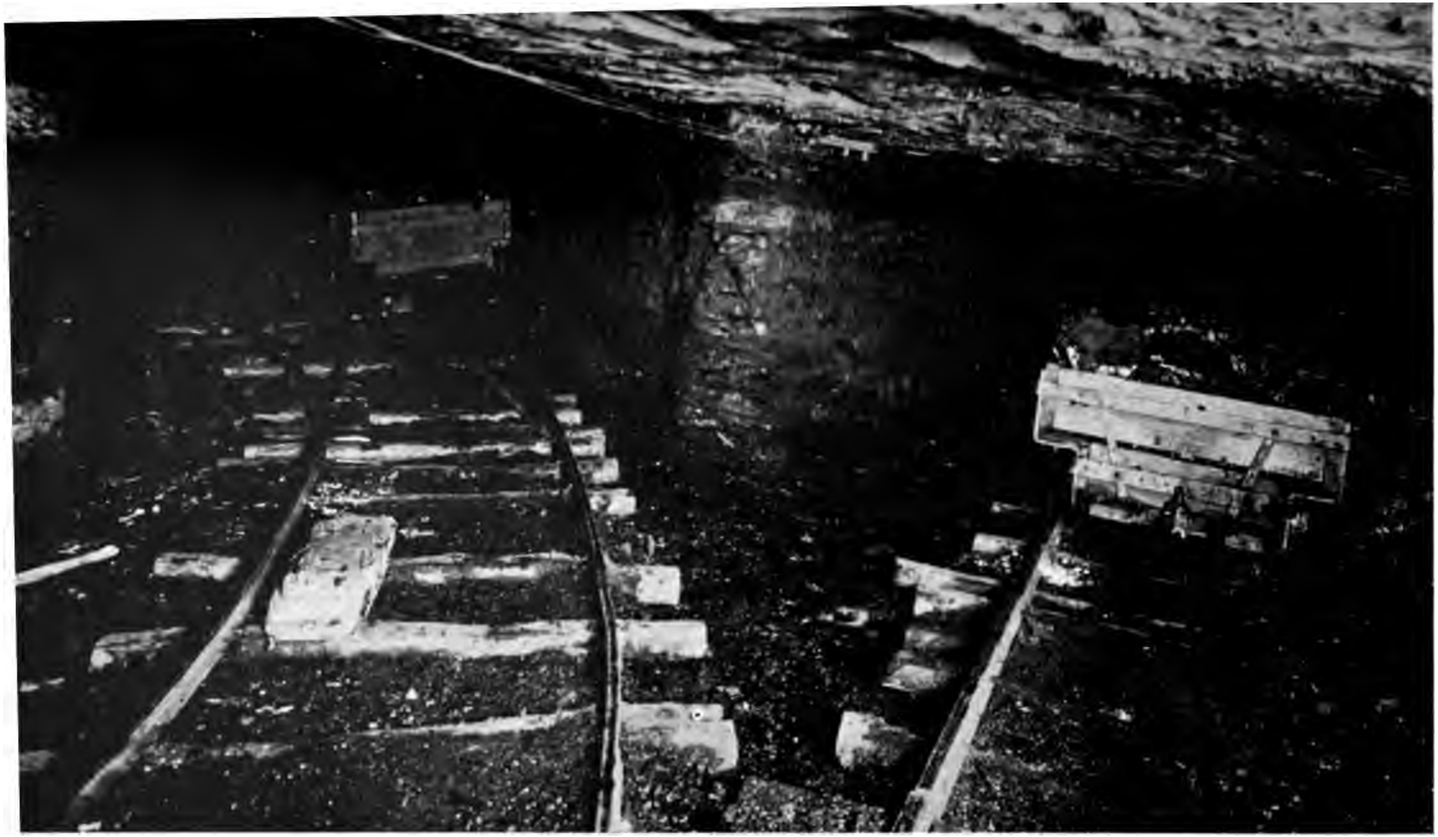


Photo B'ham View Co., 1924.

Second left entry leading eastward, and main slope leading down the pitch, 75′ below the second right entry. Mines operated by the Ragland Coal Company, Wattsville, Alabama, on the Fairview or Big Seam.

A test of the coal from the Brown mine was made by Mr. Percell, Road Foreman of Engines of the Georgia Division of the Seaboard, in 1922, quoted as follows:

"Referring to the tests made with the car of coal from Brown's mine, Coal City, Alabama, recently, Mr. Payne and myself tested this coal on Pacific and Micado engines. This coal runs very low in ash and clinkers but little, but it is a very soft coal and will slack easy from handling and weather conditions. We find that this coal throws off a very long blaze, which gives us a better super-heat than we can get from any other Alabama coal. If we can get this coal to run about 50% or 60% lump, leaving the mines, we can use it with success. It is a slow burning coal but if it runs high in slack the consumption will be high, especially so with the stoker fired engines, and will clinker worse than if it runs high in lumps."

It might be said in way of explanation that this coal was loaded from the mine chutes into wagons, hauled to the railroad where it was shoveled into cars. This method of hauling is very detrimental to a high percentage of lump. Proper hauling, that is, from the mines to the cars, will increase the lumps to and above the railroad's specifications.

Herewith are analyses of coal furnished by the Ragland Coal Company, to the Ragland Cement Plant. Each analysis represents a car load of unwashed coal:

Moisture	*Volatile*	*Fixed Carbon*	*Ash*
.60	28.24	55.62	15.51
.70	28.27	54.95	15.98
3.17	29.12	54.04	13.67
.33	29.33	55.79	14.65
.36	29.41	56.96	13.27
.43	26.87	57.30	15.40
.49	26.03	51.05	22.03
.67	27.35	54.80	17.18
.63	27.95	57.65	13.77
.64	26.65	55.73	16.98
.20	25.86	59.35	14.59
.55	27.70	50.00	12.75
.64	27.80	57.71	13.85
.35	28.95	58.00	12.70
.26	24.79	61.05	13.90
.65	26.69	55.70	14.96

A series of analyses made from samples collected in 1922 in the Brown mine by the Seaboard and analyzed for them in the Norfolk Testing Laboratories showed the following results:

Sample	*Moisture*	*Volatile*	*Fixed Carbon*	*Ash*	*Sulphur*	*B. T. U.*
No. 1-A	3.22	27.80	57.06	11.92	3.02	13,008
B		28.69	59.01	12.30	3.12	13,441
No. 2-A	2.09	27.14	58.29	12.52	4.06	13,545
B		27.68	59.55	12.77	4.16	13,821
No. 3-A	.82	27.93	63.00	8.26	2.61	14,427
B		28.15	63.52	8.33	2.63	14,546
No. 4-A	.72	21.14	46.86	31.28	----	--------
B		21.29	47.21	31.50	..	---- ....
No. 5-A	.15	23.50	44.82	31.53	4.25	9,791
B		23.53	44.89	31.58	4.26	9,810
No. 6-A	1.61	30.10	63.01	5.28	2.06	14,569
B		30.58	64.06	5.36	2.09	14,808
No. 7-A	.71	26.30	57.28	15.71	3.16	13,051
B		26.46	57.72	15.82	3.17	13,144

No. 1. General sample at 100′ including bottom seam parting.

No. 2. General sample at 200′ including bottom seam parting.

No. 3. Good bottom coal, and of right hand entry.

No. 4. Shaly coal, and of right hand entry.

No. 5. Soft shaly coal, upper part of parting, or under the hard, upper layer, end of right hand entry.

No. 6. Top coal, end of right hand air course.

No. 7. General sample, second left entry.

Samples collected from the same mine in 1921 and analyzed in the same laboratories gave the following results:

	Moisture	*Volatile*	*Fixed Carbon*	*Ash*	*Sulphur*	*B. T. U.*
	.50	30.65	60.98	7.87	3.95	14,436
Dry coal		30.80	62.12	7.91	3.96	14,506

In January, 1922, Dr. F. H. H. Calhoun, the General Development Agent for the Seaboard, made a series of measurements in the Brown mine, taken 20 feet apart, in order:

Main Slope (inches)	*Upper coal*	*Width of parting*	*Lower coal*
	14	9.5	18
	14	8.5	14
	16	11	17
	12	11	17.5
	12	15.5	17.5
	11	11	15.5
	12	7	11
	14.5	13	17.5
	11.5	11.5	17
	12	15	19
	11	13	15
	10.5	10.5	13
	12	8	17
	14.5	8	13.5
	11	11	18
First right entry			
	11.5	12	19
	10.5	14.5	21.5
	11	11	17.5
	14.5	9	19.5
	12	15	21
	11	11.5	20

At end of first right air course	12.4	11.28	17.46
	18	9	22
Left entry about 140' from end of slope	10.5	12	20.5
	12.5	12.5	22
	10.5	12	23
Average	12.40	11.28	17.46
Average of 12 pits	19.0	12	29.9

Turner estimated that the Brown mine was making 200 gallons per minute, which may be considered as a slight excess over the usual amount in mines. The writer was not able to calculate the amount of water because the mine was not in operation at the time of his visit, but there appears to be no reason why there should be more water in these beds than in any other similarly situated. Surface water has easy access to the beds on account of the dip, and it is believed that the total amount of water encountered with depth will decrease rapidly in proportion to the exposed surfaces.

Perhaps it might be well to mention here the fact that the reversals of the strata in the vicinity of the Seaboard branch line in section 6, township 16, south, range 4 east, might somewhat hamper the working in the Brown mine along the right entries. It is the opinion of the writer, however, that no trouble will be encountered until the main slope reaches a depth of 3,000 feet or more, and then the disturbance may only be noted in the entries driven to the right. Even in case trouble is found in the right entries, those leading to the left will be without danger of alteration and may be worked at any desired distance. If the right entries are lessened the question arises as to whether or not the mine can produce the requisite amount of coal. It should be made very plain that whatever disturbance actually exists in the area, is confined to the upper measures and to the eastern portion of the basin.

The Fairview seam was named from the station on the old East & West Railway, on the northeastern end of the basin.

The list of outcrops and openings on the Fairview is as follows:

1. Outcrop in SE corner in SW¼ of NE¼ S 10 T 15 S R 4 E.
2. 50" coal—5" clay near center—near E line in NE¼ of SE¼ S 9 T 15 S R 4 E—old mine, opened 1883, 100' deep.
3. 20" coal—5" clay—31" coal—near W line in NW¼ of SW¼ S 20 T 15 S R 4 E.
4. 17" coal—4" clay—30" coal—near N line in NW¼ of NE¼ S 30 T 15 S R 4 E—drift mine 100' deep.
5. 42" coal—6" clay parting center—SE¼ of NW¼ S 30 T 15 S R 4 E.
6. 48" coal—5" clay parting near center—SE part of NW¼ of SW¼ S 30 T 15 S R 4 E.

7. 17″ coal—4″ clay—29″ coal—in NW¼ of NW¼ S 31 T 15 S R 4 E.
8. 16″ coal—5″ clay—28″ coal—near N line of SE¼ of NE¼ S 36 T 15 S R 3 E.
9. 17″ coal—4″ clay—25″ coal—near E line of SW¼ of NE¼ S 36 T 15 S R 3 E.
10. 16″ coal—15″ clay—20″ coal—near W line of SW¼ of NE¼ S 6 T 15 S R 3 E —mine with main slope driven 960′, second right entry driven 1,000′ along strike, many other right entries and rooms.
11. 16″ coal—16″ clay—28″ coal—near center of NW¼ of SE¼ S 36 T 15 S R 3 E.
12. 42″ coal—6″ clay parting near center—near railroad in NW corner of SW¼ of SW¼ S 36 T 15 S R 3 E.
13. 22″ coal—7″ clay—26″ coal, near E line of SE¼ of SW¼ S 36 T 15 S R 3 E —drift mine 100′ deep.
14. Outcrop near road in NE corner of NW¼ of NW¼ S 1 T 16 S R 3 E.
15. 44″ coal—4″ clay parting near center, in NW part of NW¼ of NW¼ S 1 T 16 S R 3 E.
16. 22″ coal—10″ clay—29″ coal near E line in NE¼ of NE¼ S 2 T 16 S R 3 E.
17. 22″ coal—22″ clay—32″ coal near S line in NE¼ of NE¼ S 2 T 16 S R 3 E.
18. 24″ coal—14″ clay—30″ coal, near N line in NE¼ of NE¼ S 11 T 16 S R 3 E.
19. 19″ coal—36″ clay—35″ coal, in SW part of NE¼ of NW¼ S 11 T 16 S R 3 E.
20. Outcrop in SE part of SW¼ of NW¼ S 11 T 16 S R 3 E.
21. Outcrop in SW part of NW¼ of SW¼ S 11 T 16 S R 3 E.
22. Outcrop in SW¼ of SW¼ S 10 T 16 S R 3 E.
23. Outcrop in SW¼ of SW¼ S 10 T 16 S R 3 E.
24. 40″ coal—10″ clay parting near center in NE¼ of NE¼ S 15 T 16 S R 3 E.
25. Outcrop in SE corner in NE¼ of SW¼ S 15 T 16 S R 3 E.
26. Outcrop in SE corner of NW¼ of NW¼ S 22 T 16 S R 3 E.
27. Outcrop bored with test auger in NW part of NW¼ of SW¼ S 22 T 16 S R 3 E.
28. Outcrop in NE part of SW¼ of SW¼ S 22 T 16 S R 3 E.
29. Outcrop in SE corner of SE¼ of NE¼ S 6 T 16 S R 4 E—at Mr. Smith's house.
30. Outcrop in SWP of NW¼ S 5 T 16 S R 4 E.
31. Outcrop in NE portion of SW¼ of SW¼ S 32 T 15 S R 4 E.
32. Outcrop in NE¼ of SW¼ S 32 T 15 S R 4 E.
33. 47″ coal—6″ clay parting near center in SE corner of SE¼ of NW¼ S 32 T 15 S R 4 E.

Upper Chapman. The Upper Chapman or Ragland seam shows considerable variation in thickness in various parts of the field. A glance at the list of openings on this seam will show that the changes are due to a more or less thick clay parting, which may or may not be present. Also it will be noticed that the thicker this parting, the thicker the coal. These differences are not at all unusual in coal seams, however. The thickest parting noticed was 30 inches at number 9 pit, where a small drift mine had been in operation. It is quite likely that this parting would have decreased materially within the mine but caving and water prevented any further investigation.

The Upper Chapman averages above 30″ and may be as high as 36″, carrying a good grade of small lump coal which has high steam qualities and cokes well. This coal was put through a series of tests by Dr. J. M. Pickel, of the Department of Chemistry, the results of which are contained in Gibson's report on the Coosa Field ‡. Dr. Pickel found that the coke made by the Ragland Coal Company at Ragland at that time (1890) was as good as any produced in any of the Alabama fields and even compared favorably with samples from the Pennsylvanian fields. This coal was washed, about 100 tons mined each day, about half of which was made into coke at the mines. This coal is rather high in sulphur, from analyses of samples taken from the Wattsville Basin, but it is the opinion of the author that a considerable proportion of this sulphur content would be eliminated by washing. The coal is rather soft, crumbles easily into cubic to rectangular pieces most of which will be less than one-half an inch thick. It is entirely free from ferruginous stains, and carries a relatively small amount of sediment.

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‡ *Report* on the Coosa Coal Field by A. M. Gibson, Alabama Geol. Survey, **1895**, *pp. 43-47.*

An analysis of the coal from the Upper Chapman seam, taken from number 2 opening, is as follows:

Moisture	1.45
Volatile	27.15
Fixed Carbon	63.80
Sulphur	1.75
Ash	7.60
Total	101.75

(Analysis by Dr. R. S. Hodges, Staff Chemist, University, Alabama— 1924.)

The analyses and tests made from samples of this coal taken from the Ragland Basin will not be given here, as they have no direct bearing on the area now under discussion.

The mining conditions of this seam are very good, on the whole, since a mine operated at Ragland continuously since 1890 on this seam by the Ragland Coal Company, has met with success. In general it might be said that the overlying sandstone member, especially in the northern part of the field, would make a fairly dependable roof that would require a mininum of timbering. Wherever the sandstone becomes shaly, it will be necessary to change the plans accordingly. The shale parting can be gobbed in the mine so that this element will not cause any great depreciation in the value of the seam where the partings occur.

This coal should be washed, as a more uniform product would be secured thereby. There is a relatively large amount of water present in these measures which will have to be pumped out. Neither of these points will present any alarming expenses or difficulties, for coal-washing is not much of a draw-back anymore, and the presence of water in the mines is good insurance against dust explosions.

Operations set down on this seam could easily be worked in conjunction with the Fairview or Big seam which immediately overlies the Upper Chapman. This would cut down the costs considerably and its introduction into the mining scheme is strongly recommended.

This seam was first opened on the Chapman place, near the old Fairview station, whence the name.

The list of outcrops and openings on the Upper Chapman is as follows:

1. 30″ coal in NE part of SE¼ of NW¼ S 10 T 15 S R 4 E—old drift mine.
2. Outcrop in NE¼ of SW¼ S 9 T 15 S R 4 E.
3. Outcrop in NW¼ of SW¼ S 17 T 15 S R 4 E.
4. 42″ coal—5″ clay parting near center—near E line in NW¼ of NW¼ S 20 T 15 S R 4 E—drift mine 100″ deep.
5. Outcrop in NW corner of SW¼ of NW¼ S 20 T 15 S R 4 E—small drift mine.
6. 23″ in SE corner of SE¼ of SW¼ S 19 T 15 S R 4 E.
7. 42″ coal—10″ clay parting near center—NW¼ of NW¼ S 30 T 15 S R 4 E.
8. 28″ in NW part of SW¼ of NE¼ S 36 T 15 S R 3 E.
9. 46″ coal—30″ clay parting near center—NE part of NE¼ of SW¼ S 36 T 15 S R 3 E—small drift mine.
10. Outcrop near center of NE¼ of SW¼ S 36 T 15 S R 3 E.
11. 30″ in NE corner of SW¼ of SW¼ S 30 T 15 S R 3 E.
12. Outcrop in NE¼ of NE¼ S 2 T 16 S R 3 E.
13. Outcrop in NE¼ of NE¼ S 2 T 16 S R 3 E.
14. 38″ coal—8″ clay parting in center—SE portion of NW¼ of NE¼ S 2 T 16 S R 3 E.
15. 53″ coal—13″ clay parting near center—SE portion of SE¼ of NW¼ S 2 T 16 S R 3 E.
16. Outcrop near center of SE¼ of SE¼ S 2 T 16 S R 3 E.

16A. 32″ in SE corner of SW¼ of SW¼ S 2 T 16 S R 3 E.

17. 32″ in SE corner of NE¼ of NE¼ S 10 T 16 S R 3 E.

17A. 37″ near SE corner of NW¼ of NW¼ S 11 T 16 S R 3 E.

18. Outcrop near center of SE¼ of NE¼ S 10 T 16 S R 3E.

18A. 39″ in SE part of SW¼ of NW¼ S 11 T 16 S R 3 E.

19. Outcrop near center of SW¼ of SE¼ S 10 T 16 S R 3 E.
20. Outcrop near center of SW¼ of SW¼ S 15 T 16 S R 3 E.

20A. 37″ in SE corner of SW¼ of SW¼ S 15 T 16 S R 3 E.

21. Outcrop in NW corner of NE¼ of SE¼ S 21 T 16 S R 3 E.
22. 30″ near NE corner of NE¼ of NW¼ S 27 T 16 S R 3 E.
23. Outcrop in SE part of SW¼ of NE¼ S 32 T 16 S R 4 E.

Lower Chapman. This is the lowermost seam included in this report, and where measurements were possible, showed a rather considerable variation in thickness. The seam has an average thickness of about 20 to 24 inches. This member has never shown a clay parting, the thickness in each case representing clean coal, free from rash, clay or bone. The coal is underlain by a bed of fire clay ranging from 4 to 6 feet thick, which was prospected at number 2A and tested. The clay did not burn the color desired, however, and the matter was dropped. The Lower Chapman seam is overlain by at least 40 feet of very thin-bedded shales, which appear to be admirably suited for cement making.

Three small drift mines (numbers 2, 6 and 8) have been opened on this seam, but water and caving prevented any detailed study regarding mining conditions. The seam is overlain by an 8″ to 14″ ledge of fine-grained sandstone which gives an excellent roof. This is called "whetstone" by the miners. If tests were made on the clays underneath the coal, and found satisfactory, the two might be worked in conjunction. The coal is of excellent quality, apparently free from impurities and probably low in ash, although there are no analyses available to bear out this statement.

The name was derived from the Chapman place, near Fairview, where the seam is said to have been first opened.

The list of outcrops and openings on the Lower Chapman is as follows:

1. 23" SE portion of NE¼ of NE¼ S 10 T 15 S R 4 E.
2. 22" SE¼ of SW¼ S 10 T 15 S R 4 E--small drift mine.
2A. 26" well in SE¼ of SW¼ S 10 T 15 S R 3 E.
3. 20" NE corner of SE¼ of NE¼ S 25 T 15 S R 3 E.
4. 20" in NW corner of NE¼ of SE¼ S 25 T 15 S R 3 E.
5. Outcrop near W line in NW¼ of NE¼ S 36 T 15 S R 3 E.
6. 23" in SE portion of NE¼ of NW¼ S 26 T 15 S R 3 E small drift mine.
7. Outcrop near S line in NE¼ of NW¼ S 36 T 15 S R 3 E.
8. 26" in SW corner of SE¼ of NW¼ S 36 T 15 S R 3 E small drift mine.
9. Outcrop near E line in NW¼ of SW¼ S 36 T 15 S R 3 E.
10. 20" near center of SE¼ of SE¼ S 35 T 15 S R 3 E.
11. Outcrop in SE¼ of SE¼ S 35 T 15 S R 3 E.
12. 18" near NW corner in NW¼ of NE¼ S 2 T 16 S R 3 E.
13. Outcrop in SE corner of SW¼ of NW¼ S 2 T 16 S R 3 E.
14. 24" near NW corner of NE¼ of NE¼ S 10 T 16 S R 3 E.
15. Outcrop in SE¼ of SW¼ S 10 T 16 S R 3 E.
16. Outcrop in SE¼ of SE¼ S 16 T 16 S R 3 E.
17. Outcrop in NW corner of NW¼ of SE¼ S 21 T 16 S R 3 E.
18. 24" in SW corner of SW¼ of SE¼ S 21 T 16 S R 3 E.
19. 29" in SW portion of NW¼ of NE¼ S 28 T 16 S R 3 E.
20. Outcrop near NE corner of SE¼ of NW¼ S 27 T 16 S R 3 E.
21. Outcrop in SE corner of NE¼ of SW¼ S 32 T 15 S R 4 E.
22. 16" in SE part of NE¼ of SW¼ S 32 T 15 S R 4 E.

RESERVES

	Lower Chapman	*Upper Chapman*	*Fairview*
Average thickness	1.9'	3'	4.6'
Acreage	13,320	8,920	7,320
Foot-acre	19,508	26,760	33,672
Tons per foot-acre	1,770	1,770	1,770
Possible recovery	60%	60%	70%
Foot-acre recovery	1,100	1,100	1,250
Total reserves	21,458,800	29,436,600	42,090,000
	Higginbotham	*Gann*	*Brown*
Average thickness	2.4'	1.8'	2.7'
Acreage	6,280	6,180	3,480
Foot-acre	15,072	11,124	9,396
Tons per foot-acre	1,770	1,770	1,770
Possible recovery	60%	60%	60%
Foot-acre recovery	1,100	1,100	1,100
Total reserves	16,579,200	12,236,400	10,335,600
	Bibby	*Marion*	*Broken Arrow*
Average thickness	2'	2.5'	3'
Acreage	2,920	2,240	1,080
Foot-acre	5,840	5,600	3,240
Tons per foot-acre	1,770	1,770	1,770
Possible recovery	60%	60%	60%
Foot-acre recovery	1,100	1,100	1,100
Total reserves	6,424,000	6,160,000	3,564,000
		Coal Branch	*Hammond*
Average thickness		4'	5.25'
Acreage		560	240
Foot-acre		2,240	1,250
Tons per foot-acre		1,770	1,770
Possible recovery		70%	80%
Foot-acre recovery		1,250	1,400
Total reserves		2,800,000	625,000

Grand total, 151,709,600 short tons.

The small strip of territory which makes up the Coosa Coal Field is comparatively little altered, considering the vast amount of faulting which occurs on all sides, of the most violent nature. Many of these faults have a vertical displacement of more than a mile, bringing Cambrian strata to a level with Coal Measures. Many overthrust faults occur within the field itself, dividing the strip into numerous small basins. Minor faults occur in all the basins, usually with horizontal displacement. The result of all this faulting is that the basin structure of the field is practically destroyed, except in the region immediately surrounding Wattsville. Even this arear is disrupted by faults and compressional stresses which cause one big pivot fault and possibly several small cross fractures as shown in the map (see figure 1). The great breaks which characterized the margin of the field have reduced the basin to less than half its original size, and have plicated the margins with ridges of considerable height. Where these forces were equal, the basin was folded into a gentle synclinal, with or without cross breaks. When the forces were unequal the measures were disrupted and deformed until it is difficult to determine just what is left and how it is arranged. The synclinal served to preserve the measures, however, while the upturned strata were attacked by weathering agencies and denuded to their present level.

There are about seventeen seams in the Coosa Field, and fully as many more that either have been named locally or find recognition as markers. Several of these seams are workable and the coal is a proved merchantable grade. Mining has been carried on spasmodically, failures being accompanied by a transfer of collateral —the lands and equipment—to the concern advancing the money, until another company could be formed. Until recently there has never been any concerted effort at mining, with machinery especially designed by experts from both theory and practice, with mine maps, with adequate rail facilities and with a sound, systematic scale of wages.

The coal itself is a high grade coking coal, an excellent steam coal when provided with the proper amount of lump, works well in forge and furnace, and certain grades burn readily in grates. There is no doubt but that the coal will find a ready market, provided that it is properly prepared for market. The ash content is low enough, and probably will be further reduced in washed samples. It seems that the coals from the eastern part of the

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GEOLOGICAL SURVEY OF ALABAMA
WALTER BRYAN JONES, STATE GEOLOGIST

CIRCULAR 7

SUMMARY REPORT ON
THE BAUXITE DEPOSITS OF ALABAMA

BY
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STATE GEOLOGIST

UNIVERSITY, ALABAMA
JULY, [illegible]

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BIRMINGHAM PRINTING COMPANY
BPCo
PUBLISHERS

LETTER OF TRANSMITTAL

University, Alabama,
July 22, 1929.

HON. BIBB GRAVES,
Governor of Alabama,
Montgomery, Alabama.

SIR:

I have the honor to transmit herewith the manuscript of my report entitled "Summary Report on the Bauxite Deposits of Alabama," with the request that it be printed as Circular Number 7, of the Geological Survey of Alabama.

Very respectfully,

WALTER B. JONES,
State Geologist.

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·INTRODUCTION

Bauxite received its name from the town of Baux, in Southern France, where it was first discovered in 1821. Since that time it has been found in many countries, and associated with widely variable geological formations. Its early history in the United States appears to have been the original discovery in Pike County, Georgia, in 1887, followed by Rock Run, Cherokee County, Alabama, in 1889, and Pulaski County, Arkansas, in 1891.

The discovery of bauxite in Alabama is attributed to a curious mine foreman engaged in the removal of brown ore from the Rock Run ore banks, to supply the historic Bass Furnace at that place. It appears that this foreman sent some of this so-called "iron ore blossom" to the laboratories of the company, where it was determined that the material was quite similar to the ores at Baux. It is interesting to note that the area of discovery has the largest number of deposits of bauxite yet recorded from the State.

The mining of bauxite in this region by the Republic Mining and Manufacturing Company led to the discovery of many other ore bodies in this general region. In 1919 the extensive deposits of bauxite in the Georgia coastal plain were traced across the Chattahoochee River into Henry and Barbour Counties. In 1921, J. W. Adams, a prospector of Sheffield, discovered a group of small ore bodies in the vicinity of Margerum, in Colbert County.

Deposits

There are three distinct groups of bauxite deposits (See figure 1) in Alabama, which are named in the order of their discovery:

1. Cambro-Ordovician contact, with the main ore bodies centered about Rock Run, in Cherokee County, and in isolated areas in Calhoun, Talladega and DeKalb Counties.

2. Midway-Nanafalia contact, with deposits near Richards' Cross Roads and Alexander's Mill in Barbour and Henry Counties.

3. Mississippian-Tuscaloosa contact, with deposits known near Margerum, in Colbert County.

Due to similar geological conditions extending over larger areas than those in which bauxite is actually known, it is predicted that additional ore bodies will be found in other parts of the State (See shaded areas of figure 1).

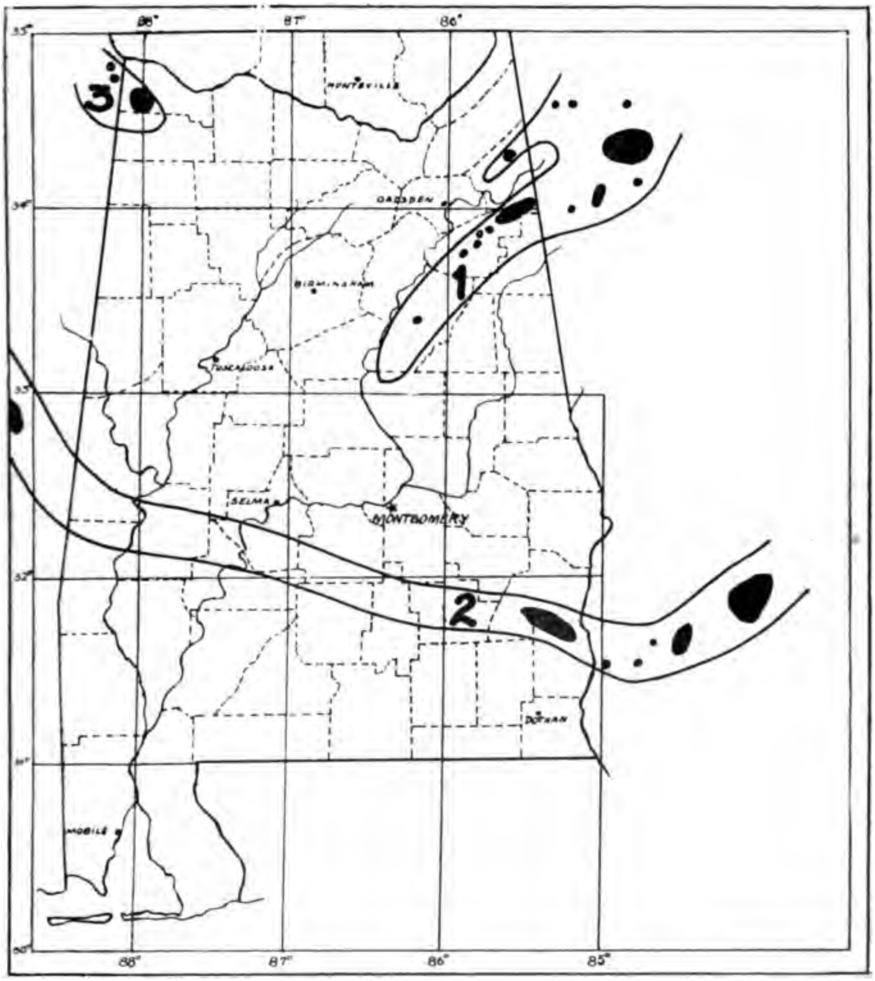

FIGURE 1

Sketch map of Alabama, showing the distribution of known deposits of bauxite, and possible areas (within black lines).

GROUP 1—CAMBRO-ORDOVICIAN CONTACT

This group of deposits has furnished the greater part of the bauxite production of the State, and includes three known ore bodies in DeKalb, thirty-one in Cherokee, nine in Calhoun and one in Talladega counties, or a total of forty-four for the area. Twenty-four of the ore bodies in Cherokee County are within six miles of Rock Run.

As stated previously, the original discovery of bauxite in this area was in brown ore pits, the bauxite occupying deep, irregularly shaped pockets. The dimensions usually were about twice as wide as deep, but with a somewhat irregular outline. Since the mining was by open pits, much ore was abandoned in the sides or bottom of workings where the overburden was too great to remove profitably.

The original discovery seems to have been made by J. R. Trotter* in the Spring of 1889, at the Dykes limonite banks. At the time of McCalley's article on the subject, only a little more than two years after its discovery, occurrences of bauxite were also known at Piedmont, Jacksonville and Anniston. Although considerable mining and prospecting has been carried on since that time, the areal distribution of bauxite has not been materially extended. However, numerous additional deposits were uncovered in the known areas, particularly in the vicinity of Rock Run.

The deposits occur in the eastern portion of the Coosa Valley, in low-lying hills adjacent to the Indian Range which is composed of Weisner quartzite. Most of the deposits are readily accessible.

Stratigraphy. It appears that most of the deposits of this group occur near the top of the Conasauga formation of Upper Cambrian age, with a few scattered ore bodies in the Shady limestone and the Chepultepec and Copper Ridge dolomites (undifferentiated) of Cambrian or Ordovician age. Most of these deposits occur near the unconformable or faulted contact of the Conasauga and Weisner quartzite. The only important exceptions to this are the Fort Payne and Talladega deposits, which are far removed from any known exposures of the Weisner.

The type section is as follows:

---

*This is disputed by R. S. Perry, who says he discovered the first deposit in April or May, 1890, about 8 miles south of Piedmont, Calhoun County. In McCalley, Henry, Alabama Bauxite. Ala. Ind. & Sci. Soc., Vol. 2, p. 21, 1892.

PALEOZOIC	Devonian	Hamilton to Onondaga	Frog Mountain	350′	Red sandstone, calcareous, with thin limestone members, rich in fossils of Middle Devonian age. The fossil locality is near Ragland, in St. Clair County, and is about 10 feet thick.
		Schohari	Yellow Leaf	?	Quartzitic schist, unfossiliferous, and unknown thickness.
		Oriskany	Jemison	100′	Chert, sparingly fossiliferous.
	Silurian				Apparently absent.
	Ordovician	Chazy	Little Oak	500′	Pure, massive, bedded limestone, mostly dark with light brown streaks. Abundantly fossiliferous, both as to species and individuals.
			Athens	200′	Black, fissile, calcareous shell, with a few thin layers of dark limestone. These beds carry an abundance of graptolites.
		Beekmantown	Newala	1000′	Non-cherty limestone, thin to thick bedded, compact and predominantly pearl-gray in color. Abundantly fossiliferous.
			Longview	500′	Mostly cherty limestone with little magnesian limestone, and sparingly fossiliferous. Not widespread in the region.
	Ozarkian (*Cambrian or Ordovician*)	(Knox)	Chepultepec	1100′	Light gray, massive bedded limestone near the base, and dark blue, thick bedded dolomite above, which give rise to cavernous and fossiliferous chert, which is characteristic of the formation.
			Copper Ridge	2000′	Dolomite, light gray, thick bedded and probably siliceous. Weathers down in chert which is composed of microscopic crystals of quartz. This chert characterizes the formation. Carries a few *Cryptozoa*.
			Bibb	?	Probably not represented.
			Ketona	300′	Very pure dolomite. Probably represented, and provisionally identified by Butts south of Anniston.
			Brierfield	?	Not certainly known but probably not represented.
	Cambrian	Upper	Conasauga (Coosa)	500′	Limestone and dolomite, shaly in places, and usually thin bedded. Upon reaching, the beds appear to be shale, preserving the original bedding planes of the limestone. Abundantly fossiliferous.
		Middle	Rome (Montevallo)	1000′	Red and variegated shales and calcareous sandstone, with local lenses of limestone or dolomite. The red shales characterize the formation.
		Lower	Shady (Aldrich or Beaver)	500′	Limestone, sparingly fossiliferous, mostly thick bedded and in part fine grained and approaching a marble which takes a good polish.
			Weisner	2000′	Quartzite or quartzitic sandstone, conglomerates, shale, slate and in places lenses of sandy hematite (gray ore). Apparently unfossiliferous.

The area in which the bauxite occurs is strongly folded and faulted and the structure is very complex, although the trend of the beds largely conform to the general trend of the Appalachians.

FORM AND CHARACTER

The bauxite deposits of this area occur along with the brown ores, and are further associated with clays, which often form "horses" within the bauxite bodies. From the Georgia line the lead seems to divide, branches running on each side of an outcrop of Frog Mountain sandstone. The southernmost of the leads plays out in the southeastern part of Cherokee County, while the other continues through to Talladega. McCalley* says the two leads occupy sharp anticlinals, with a synclinal between them, and that this synclinal should also carry bauxite.

Many of the ore bodies already mined out are pot-shaped (See Plate 1 A and B), usually about half as deep as wide. One of the largest in the district is the Murnaghan cut, which is about 360 feet northeast and southwest, about 285 feet across and 110 feet deep.

The ore ranges from earthly to pisolitic, soft to hard and even ferruginous bauxite carrying more than 20% iron oxide. The following analyses will serve to show the principal types:

	1	2	3	4	5	6	7	8	9
SiO_2	28.2	8.5	9.5	4.5	34.2	9.3	58.8	5.4	2.0
Al_2O_3	46.0	58.0	53.8	60.8	44.1	59.5	25.6	56.2	63.5
Fe_2O_3	1.0	3.8	6.0	1.1	1.6	1.3	1.2	6.4	1.7
TiO_2	2.0	2.2	4.0	2.4	2.4	2.3	1.0	3.0	3.7
Ign	22.8	27.5	26.7	31.2	17.7	27.6	13.4	29.0	29.1
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
SiO_2	6.9	17.7	5.3	2.8	13.7	45.7	11.7	10.6	45.2
Al_2O_3	54.3	53.8	40.1	61.7	21.3	38.1	57.3	56.7	38.8
Fe_2O_3	8.3	1.1	32.2	1.4	51.5	0.5	0.4	2.8	1.7
TiO_2	3.5	2.6	1.3	4.0	2.2	1.7	2.8	2.0	1.5
Ign	27.0	24.8	21.1	30.1	11.3	14.0	27.8	27.9	12.8

1. Carr Bank, hard pisolitic ore cemented with Silica.
2. Estes Bank, soft pisolitic ore, high grade.
3. Do. Boulder of hard, pisolitic ore, rather ferruginous.
4. War-Whoop Bank, soft, pisolitic ore of high quality.
5. Do. Boulder of hard ore, cemented with Silica.
6. Gaines Hill bank, soft ore.
7. Do. Clay from "horse" in the side of the pit.
8. Burst-up Bank, average of good soft ore, reddish color.
9. Do. High-grade soft ore.
10. Do. Boulder of hard ore, cemented with iron oxide.
11. Do. Boulder of hard ore, cemented with Silica.
12. Old Dyke Bank, boulder of hard ore, cemented with iron oxide.
13. Pine Cut Bank, boulder of high-grade hard ore, cemented with bauxite.
14. Red Cut Bank, boulder cemented with iron oxide.
15. Camp McClellan, near Anniston, soft bauxite clay, pisolitic.
16. Skinner Ore Banks, near Anniston, very good pisolitic soft ore.
17. Parsons Cut, near Talladega, soft ore as shipped.
18. Do. buff clay forming bank on the east side.

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*McCalley, Henry *op. cit.*, pp. 22-28.

PLATE 1
A. Looking southeast over the Murnaghan cut. June 10, 1926

PLATE 1
B. Looking northeast over the Tierce cut, where a large amount of ore was removed. June 9, 1926.

Photos--Walter B. Jones.

MINING

The actual mining of bauxite began soon after its discovery, and has continued since, although there was a complete cessation of activities for a few years after the World War. The mining was entirely by the open pit method, and the clay and debris piled up alongside the cuts. From the size of some of these dumps, it would seem that little or no ore was shipped! The Murnaghan cut, according to a man employed in the workings at the time, had ore in the bottom and a 30-foot ledge in the northwest wall, when it was abandoned in 1919. This mine started about 1900. The old Sep Dyke pit must have produced at least 20,000 tons, in the 15 years it was mined, while Burst-up supplied 14,000 tons the last year it was operated. In this mine there was left a body of ore 40 feet high and 80 feet wide, and it is estimated that that wall alone will supply 10,000 tons of ore.

Some bauxite was mined during the war, from the Fort Payne deposits and from that at Talladega, but little other mining has been done in the area.

LIST OF DEPOSITS IN GROUP 1

DEKALB COUNTY

1. S 10, T 6, R 9 E.
2. S 9, T 6, R 9 E.
3. S 2, T 7, R 8 E.
4. S 30, T 6, R 9 E. (Fullers Earth)

CHEROKEE COUNTY

5. SE¼ S 34, T 11, R 10 E.
6. Carr Banks, NE¼ NW¼ S 25, T 11, R 11 E.
7. Bogan cut, SE¼ SW¼ S 24, T 11, R 11 E.
8. Estes Bank, SE¼ NE¼, S 24, T 11, R 11 E.
9. Klondike, NW¼ SE¼, S 23, T 11, R 11 E.
10. Wilson Cut, NE¼ SE¼, S 23, T 11, R 11 E.
11. Hite bank, SE¼ NW¼, S 23, T 11, R 11 E.
12. War-Whoop. SW¼ NW¼, S 25, T 11, R 11 E.
13. Gaines Hill. NE¼ SE¼, S 26, T 11, R 11 E.
14. Tomahawk. NW¼ SE¼, S 26, T 11, R 11 E.
15. Tierce. NW¼ SE¼, S 26, T 11, R 11 E.
16. Boost-Up. SW¼ SE¼, S 26, T 11, R 11 E.
17. Old-Dyke. SW¼ SE¼, S 26, T 11, R 11 E.
18. Indian Dyke. SW¼ SE¼, S 26, T 11, R 11 E.

19-A. No. 138. SW¼ SE¼, S 26, T 11, R 11 E.

19-B. No. 138. SW¼ SE¼, S 26, T 11, R 11 E.

20. Pine Cut. SW¼ SE¼, S 26, T 11, R 11 E.
21. Red Cut. SW¼ SE¼, S 26, T 11, R 11 E.
22. New Dyke. SW¼ SE¼, S 26, T 11, R 11 E.
23. Outcrop. NW¼ NE¼, S 35, T 11, R 11 E.
24. Washer Bank. SW¼ SW¼, S 35, T 11, R 11 E.
25. Murnaghan Cut. SW¼ SW¼, S 35, T 11, R 11 E.

26. Red Shaft. SW¼ SW¼, S 35, T 11, R 11 E.
27. Red Washer. SW¼ SW¼, S 35, T 11, R 11 E.
28. Stubbs Hill. SW¼ SE¼, S 28, T 11, R 11 E.
29. Snyder. NW¼, S 7, T 12, R 10 E.
30. New Stewart. NE corner S 7.
31. Old Stewart. SE corner S 6.
32. Cowan Cut SE¼ NW¼, S 13, T 12, R 9 E.
33. Rumsey. NW¼, S 14, T 12, R 9 E.
34. Lee No. 1, NW¼ SW¼, S 14.
35. Lee No. 2, NW¼ SW¼, S 14.

CALHOUN COUNTY

36. Walker or Windem Pits. SE¼ S 12, T 14, R 8 E.
37. Crow outcrop. In Jacksonville.
38. Love Cut. SE¼ S 16, T 14, R 9 E.
39. Camp McClellan Pits. 5,000 yds. N and 2,000 yds. E of Anniston, near Remount Road.
40. Dothard Outcrop. NW corner, S 3, T 14 S, R 9 E.
41. Borden Outcrop. SW corner, S 34, T 13 S, R 9 E.
42. McClellan Prospect. SE¼ SW¼ S 33, T 13, R 9 E.
43. Skinner Ore banks No. 1. Near Anniston.
44. Skinner Ore banks No. 2. Near Anniston.

TALLADEGA COUNTY

45. Parsons Cut. S 34, T 18, R 5 E, ¾ mi. S. of Courthouse at Talladega.

GROUP 2—MIDWAY-NANAFALIA CONTACT

This group carries rather extensive deposits of bauxite in Barbour and Henry counties, and the only mining now being done in the State is in Barbour County. These deposits were discovered and prospected by the Republic Mining and Manufacturing Company, of Hermitage, Georgia. The detailed examination of the deposits was under the direction of Rettger,* who published an account of the work and a description of the deposits. In outlining the prospecting, he said:

> "The writer has recently done considerable detailed work in the district and has had an opportunity to study the various deposits. During the prospecting, which covered a period of about twelve months, some 200 different "shows" were tested on more than 60 properties. From these 200 "shows", 75 deposits were outlined containing a fair amount of merchantable ore. The prospecting consisted of test-pitting and drilling, and in all more than 2,000 bore holes were put down supplemented by many test pits. About 1,000 partial analyses (SiO_2, Fe_2O_3, Al_2O_3, TiO_2, and loss on ignition) were made of bauxite and associated clay."

In the summer of 1925, the author spent nearly two months in the area, studying the deposits as best he could from such information as was still available from outcrops of Rettger's exploration work. Many samples were taken, from which partial analyses were made, and deposit 2 in particular was very carefully studied and sampled. (See Plate 2 A and B.) The section through this deposit is as follows:

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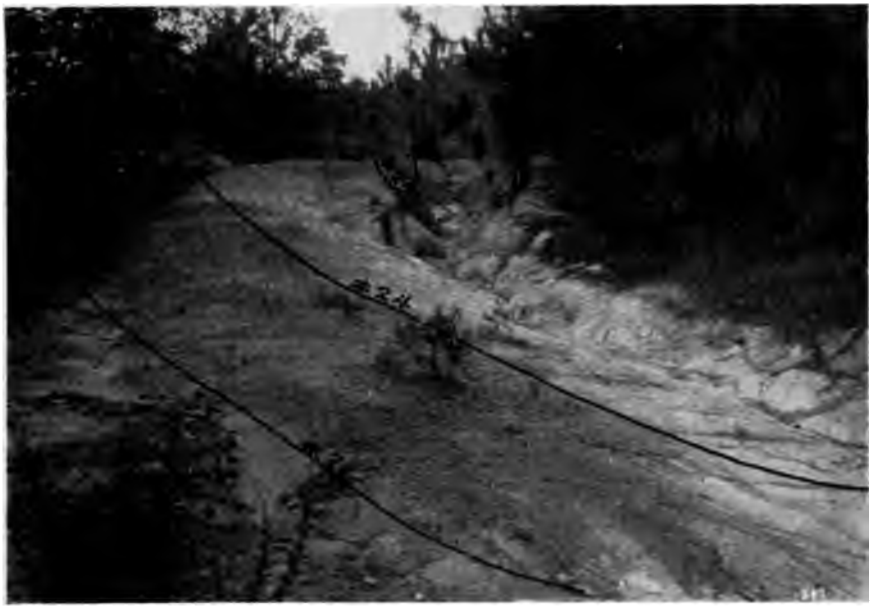
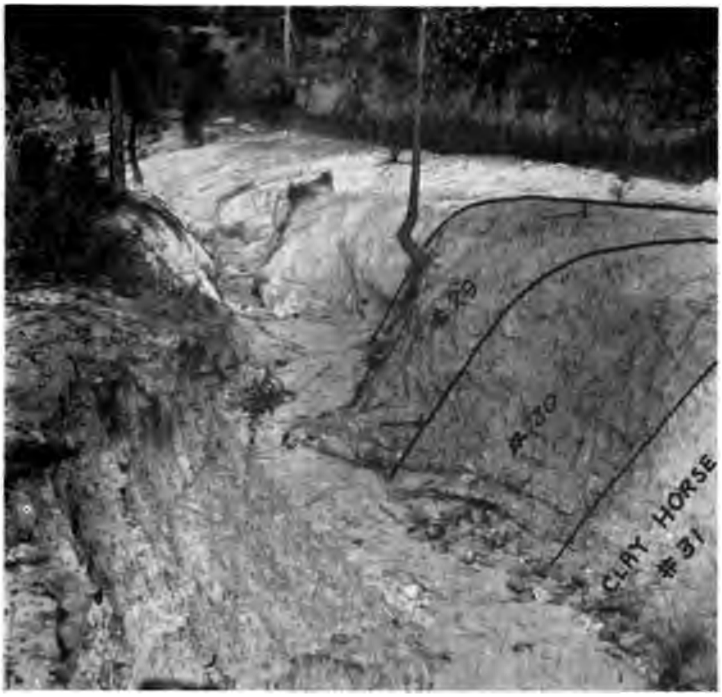
*Rettger, R. E., The Bauxite Deposits of Southeastern Alabama. Econ. Geol., Vol. 20, Nov., 1925, pp. 671-686.

PLATE 2



A. Deposit Z, looking up the old road from bed No. 22, showing the trend of the layers. The best bauxite is carried in beds 19-29, inclusive.



B. Looking down the road at deposit Z, showing the clay horse and adjoining beds

Photos—Walter B. Jones, August 26, 1925.

Bed No.	*Thickness*	*% Al_2O_3*	*Description*
1	10′	10.9	Micaceous sand and clay
2	10′	6.1	Very coarse micaceous sand
3	6′	46.8	Bauxitic clay
4	3′	50.5	Ferruginous bauxitic clay
5	10′	37.3	White potters clay
6	15′	36.5	Red to white clay
7	20	33.1	Variegated coarse lumpy clay
8	15	41.7	Potters clay ,mostly white
9	35	13.3	Coarse, ferruginous yellow sand and clay, with clay ironstones
10	8	53.0	White to buff bauxite
11	6′	50.8	Ferruginous bauxite—hard ore and boulders
12	4′	49.2	Do., with tendency to crumble
13	10′	50.8	White bauxitic clay
14	9	16.3	Brown and variegated sandy clays, with some bauxite pisolites
15	10′	12.4	Buff sandy clay
16	10′	50.8	Red ferruginous bauxite and clay
17	16′	8.2	Red sand
18	6′	34.9	White bauxitic clay
19	5′	53.9	White bauxite, pisolitic
20	8′	52.7	White bauxite
21	6′	55.7	White and buff bauxite, pisolitic
22	4′	56.4	Do., but more uniformly pisolitic
23	8′	54.7	White bauxite
24	4′	58.4	Do.
25	4′	58.9	Do.
26	8′	60.1	Do.
27	7′	58.4	Buckshot ore
28	5′	54.6	Do.
29	5′	52.2	Do.
30	3′	34.2	Bedded, variegated clays, ferruginous
31	7′	36.6	Clay "horse", of white, buff, yellow and red clays
32	4′	43.4	Yellow clay, opposite of No. 30
33	4′	50.6	White bauxite, like No. 29
34	8′	52.8	Pisolitic bauxite, like No. 28
35	6′	54.9	Do., like No. 27

(West end of section)

Stratigraphy. The formations actually carrying the bauxite are the Clayton limestone of Midway age, and the Nanafalia. These and associated formations are shown in the following table:

Eocene	Wilcox	Nanafalia	175'	Sands and clays, characterized by beds of *Ostrea thirsae* and pseudobuhrstone, with an abundance of fossils.
		Interval		Unconformity
	Midway	Naheola	110'	Light colored sands and clays, apparently without fossils, and probably represents continental equivalent of the marine beds of West Alabama.
		Interval		Unconformity
		Clayton	200'	Type locality at Clayton, Barbour County, where it consists of white to buff limestone, and calcareous sands. The limestones are abundantly fossiliferous.
Cretaceous	Upper	Interval		Unconformity
		Providance Sand	100'	Coarse red and light colored sands and sandy clay, without fossils, probably representing the typical Providence Sand of Georgia and shallow water deposition.
		Ripley	1000'	Predominating dark glauconitic sands, with interbedded clay and sandy clays, mostly marine and abundantly fossiliferous. The formation gives rise to rugged topography.

The bauxite occurs in erosion channels in the Clayton limestone, near the contact with the Naheola clays and Nanafalia sands. The eroded surface of the Clayton is clearly exposed on the Chattahoochee River, and is described by Cooke,* as follows:

> "On Chattahoochee River the Nanafalia formation lies directly upon the Clayton limestone. Ancient sink-holes in the Clayton filled with white micaceous sand are plainly exposed on the west bank of the river above the old wagon bridge at Fort Gaines."

While in the area in 1925, the writer measured two sections of the lowermost Naheola beds, near the contact with the Clayton, and are given below:

In branch, one-fourth mile northeast of Baker Hill.

Top	Debris from the top of the hill
9'	Lignite
3'	Black clay
2½'	White to light gray clay, with iron stains
4'	Deep red to variegated ocher-clay
2'	Yellow clay
15'	White clay

In branch, just east of Baker Hill

15'	Clays and lignite
2'	Mixture of limonite and ferruginous sandstone
5'	Yellow ocher, apparently high grade
20'	White to yellow clays

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*Cooke, C. Wythe, Geology of Alabama. Sp. Rpt. 14, Geol. Surv. of Ala., p. 261, 1926.

Near J. W. Floyd's house, southeast of Baker Hill, there is a fine outcrop of some 30 feet of Clayton limestone carrying an abundance of *Ostrea crenulimarginata*, within a short distance of a deposit (No. 4) of bauxite.

Form and Character. The deposits are irregularly shaped ore bodies, some of which show evidence of bedding, and carry ore which ranges from earthy ore to boulders of hard, firmly cemented pisolitic bauxite. Many of the ore bodies carry high-grade ore, and as a whole, the ore is very promising. There is very little of the highly ferruginous ore which characterizes the Rock Run deposits.

The following analyses show the variety of ores:

	1	2	3	4	5	6	7	8
SiO_2	22.1	11.9	8.5	7.2	29.9	3.8	11.2	16.3
Al_2O_3	51.1	46.5	60.5	58.4	47.1	61.1	42.5	58.1
Fe_2O_3	.1	13.4	.4	.1	.2	.2	19.2	.1
TiO_2	2.5	1.9	3.7	2.8	1.6	2.2	1.8	2.2
Ign	23.8	26.3	26.9	31.4	21.2	32.7	25.4	29.3

	9	10	11	12	13	14	15	16
SiO_2	8.7	14.9	11.7	10.8	7.3	4.9	20.9	11.3
Al_2O_3	46.1	53.9	55.7	56.4	58.4	60.1	52.2	39.8
Fe_2O_3	16.9	1.3	.7	1.0	1.1	.5	.6	23.5
TiO_2	2.2	2.1	2.4	2.3	3.7	3.7	2.8	2.4
Ign	26.1	28.8	29.4	29.5	29.5	30.8	23.5	23.0

1. A., sample 1.
2. D.
3. G.
4. J.
5. L.
6. O.
7. Q.
8. 5.
9. Y. (Boulder).
10. Z-19.
11. Z-21.
12. Z-22.
13. Z-24.
14. Z-26.
15. Z-29.
16. 7, sample A.

Mining. In the spring of 1927, the Republic Mining and Manufacturing Company, of Hermitage, Georgia, stripped one of the best ore-bodies on the Dent place (F) and another near Richards Cross Roads (X-O), and has been mining since that time (see Plate 3 A B). The haul is by truck to Eufaula, some 13 miles away. Were railway facilities more convenient, it is likely that more of these deposits would be mined.

LIST OF DEPOSITS IN GROUP 2

BARBOUR COUNTY

Deposit	*Location*
A	NE¼ S 20, T 9, R 28 E.
B	SE¼ S 17, T 9, R 28 E.
C	SW¼ S 17, T 9, R 28 E.
D	NE¼ S 18, T 9, R 28 E.
E	Center S 18, T 9, R 28 E.
F	SE¼ S 18, T 9, R 28 E.
G	SE¼ S 18, T 9, R 28 E.
H	NE¼ S 19, T 9, R 28 E.
I	NE¼ S 20, T 9, R 28 E.
J	NE¼ S 20, T 9, R 28 E.
K	NW¼ S 21, T 9, R 28 E.
L	NE¼ S 20, T 9, R 28 E.
M	NW¼ S 21, T 9, R 28 E.
N	SE¼ S 20, T 9, R 28 E.
O	SE¼ S 20, T 9, R 28 E.
P	SE¼ S 20, T 9, R 28 E.
Q	SW¼ S 21, T 9, R 28 E.
R	South half S 21, T 9, R 28 E.
S	SE¼ S 21, T 9, R 28 E.
T	SW¼ S 21, T 9, R 28 E.
U	SW¼ S 21, T 9, R 28 E.
V	SE¼ S 20, T 9, R 28 E.
W	SE¼ S 20, T 9, R 28 E.
X	SW¼ S 20, T 9, R 28 E.
Y	NW¼ S 15, T 9, R 28 E.
Z	NE part of SE¼ of S 20, T 9, R 28 E.
No. 1	Next to *J* in the NE¼ S 20, T 9, R 28 E.
No. 2	SE¼ S 26, T 9, R 28 E.
No. 4	NE¼ S 13, T 9, R 28 E.
No. 5	SE¼ S 13, T 9, R 28 E.
No. 13	NE¼ S 10, T 9, R 28 E.

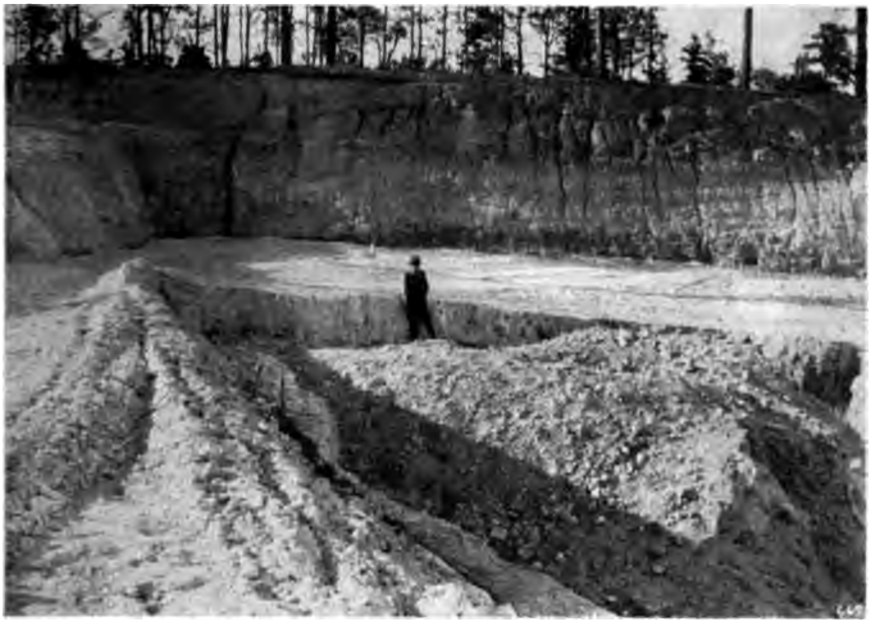
HENRY COUNTY

No. 3	NE¼ S 4, T 8, R 27 E.
No. 6	SE¼ S 24, T 9, R 28 E.
No. 7	NE¼ S 36, T 9, R 28 E.
No. 8	NE¼ S 36, T 9, R 28 E.
No. 9	SW¼ S 20, T 9, R 29 E.
No. 10	NW¼ NW¼ S 8, T 8, R 29 E.
No. 11	North half S 12, T 8, R 28 E.
No. 12	NE¼ S 1, T 8, R 28 E.

GROUP 3—MISSISSIPPIAN-TUSCALOOSA CONTACT

Deposits of bauxite belonging to this group are found near Margerum, in Colbert County, and bauxitic clay just across the State line in Tishomingo County, Mississippi. The Colbert County deposits are just south of the Tennessee River, and south of Margerum, a station on the Memphis-Chattanooga division of the Southern Railway System.

PLATE 3



A. Stripped ore body on the Dent place, with a ledge of high grade bauxite exposed, and a mass in the center foreground ready for loading on the trucks. The overlying clays are definitely bedded.

B. Ore-body in process of stripping, one mile east of Richards Cross-Roads. High grade bauxite has already been uncovered in the central portion of the area.
Photos—Walter B. Jones, June 11, 1927.

These deposits were discovered in 1921 by J. W. Adams, prospector of Sheffield, and mentioned by Burchard*, who says:

"In the fall of 1921 J. W. Adams, of Tuscumbia, Alabama, in prospecting for clays, discovered deposits of bauxite and bauxitic clays near Margerum, Colbert County, Alabama. These deposits are in erosion channels and sink holes in Mississippian limestones that have been partly filled by Cretaceous (Tuscaloosa) gravel."

During 1923 and 1924, Mr. Adams prospected the area very thoroughly, sinking some fifty test pits and about a dozen trenches, outlining several rather attractive ore bodies running between 48 and 55 per cent alumina. The writer carried out his investigations in the area in the summer of 1925, and all of the results of the previous work as well as a very comfortable camp, were placed at his disposal. He wishes to acknowledge this splendid cooperation.

The area is a rather rugged upland, near the western terminus of the Tuscumbia Mountain, and about 600 feet above sea level, with a difference of elevation of about 200 feet. Bear Creek drains the region. The area is rather inaccessible at the present time, but is susceptible to the construction of satisfactory roads or even a spur track from the Southern system. Margerum would be the nearest shipping point.

Stratigraphy. The formations exposed in the Margerum district are largely Mississippian, with a blanket of Cretaceous (Tuscaloosa) clays and gravel. The section is as follows:

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*Burchard, E. F., Bauxite in Northeastern Mississippi. U. S. G. S. Bull. 750-G, 1925, pp. 101-146.

CRETACEOUS		Tuscaloosa Formation	Sand and gravel, with some clay and clay lenses.
Unconformity			
PENNSYLVANIAN		Coal Measures	Mostly massive bedded sandstones, white to very dark in color. Some thin shale beds. No coals in the lower 200 feet.
MISSISSIPPIAN	Chester Group	Bangor Limestone	Massive bedded fossiliferous limestone, and occasional shale beds. Carries two oolitic members, the upper being very persistent. In all about 400 feet thick.
		Hartselle Sandstone (Golconda, Cypress)	Massive bedded sandstone, with one asphaltic member. About 200 feet thick.
	Monte Sano Group	Gasper	Shale at top, shaly limestone in the middle and limestone at the bottom. Asphaltic oolite near base. Extremely fossiliferous throughout. 240 feet thick.
		Bethel	Asphaltic sandstone, 20 feet thick.
		St. Genevieve	Mostly blue shale and marl, with a ledge of limestone at base which is abundantly fossiliferous. 60 feet thick.
	Tuscumbia Group	Tuscumbia or Warsaw Limestone	Massive to thin bedded, dark blue cherty limestone, abundant fossils. About 150 feet thick.
	Osage Group	Lauderdale Chert	Chert and cherty limestone, stratified and fossiliferous. About 225 feet thick.
Unconformity			

There are several fine key beds which enable one to work out the stratigraphic relations accurately and easily, of which perhaps the best are the ledge forming asphaltic members of the Bethel and Gasper formations. Between the asphaltic beds are limestones with abundant silicified fossils that are everywhere thickly matted in the residual soils accumulated over the limestone beds. Another excellent key bed is the layer of *Productus* limestone about one foot thick at the base of the St. Genevieve formation. This bed is probably encountered more frequently than any other, occurring as it does just below thin bedded shales that are readily disintegrated by weathering agencies, and capping the massive bedded cherty limestones of the Tuscumbia formation, which weather away very slowly. The Hartselle sandstone makes a good tie point for the upper part of the section.

The surface in the immediate vicinity of the bauxite deposits is almost entirely covered with Tuscaloosa sand and gravel. This blanket was obviously laid down on the much-dissected surface of the Mississippian land mass after the long period of emergence. Moreover, it appears that the drainage has not been materially changed from the Post-Mississippian pattern, a view supported by the fact that rock outcrops are found at all altitudes, wherever erosion has removed the Cretaceous sediments: A fine example of this occurs in the midst of the bauxite deposits, where several huge boulders of asphaltic oolite (Gasper), surrounded by Tuscaloosa sands, jut out from the side of a ridge.

Form and Character. The ore bodies of this area are widely distributed and always occupy nests in the thicker portions of the remaining remnants of Tuscaloosa gravel and clays. In no case were they seen to rest directly upon Mississippian beds. Also, they invariably pass downward into bauxitic clay and clays. In shape, the bodies are irregular. In size, they carry from a few pounds of ore, as observed in one of the shafts, to moderately large bodies several hundred feet in diameter.

The ore is generally pisolitic, with a matrix of chalky material of essentially the same composition as the pisolites. Most of the ore bodies have numerous small streaks of iron carbonate, often weathered to limonite, with some traces of manganese. Frequently these siderite veinlets show evidence of pisolitic texture, suggesting that they were formed at a later period than the bauxite. There is little or no ore in this region that comes under the classification of "hard ore", so characteristic of the other deposits of the State. The predominating type is the loosely cemented pisolitic soft ore which disintegrates

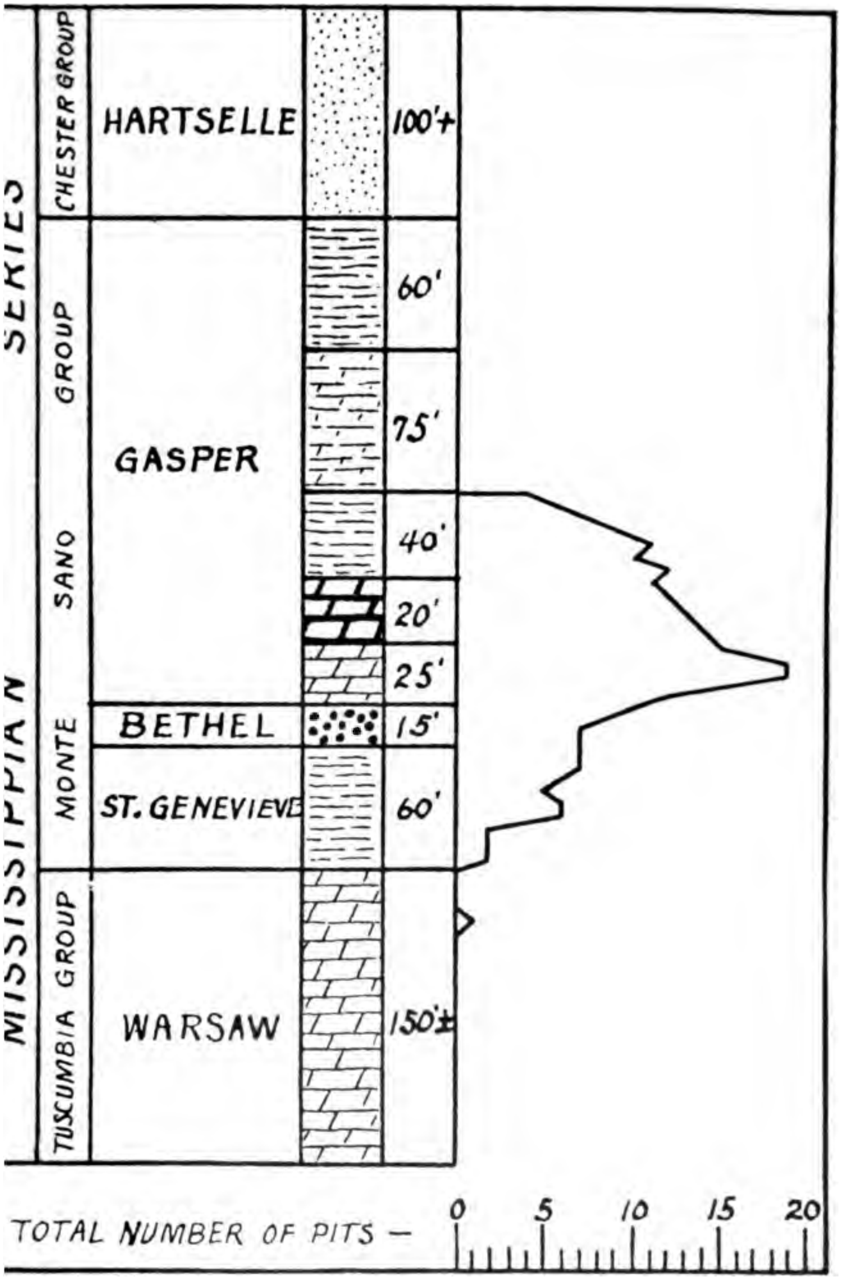

Fig. 2. Vertical section of beds exposed in the Margerum District, with curve wing the stratigraphic position of the test pits cutting bauxite. Note concentration bauxite at the Gasper and Bethel asphaltic members. *After Jones, in Econ. Geol., l. 21, p. 799.*

LIST OF DEPOSITS IN GROUP 3

No.	*Type*	*Location*
2	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
3	Pits,	NW¼ NW¼, S 24, T 4, R 15 W.
4	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
7	Pit.	NW¼ NW¼, S 24, T 4, R 15 W.
8	Trench,	NE¼ NE¼, S 23, T 4, R 15 W.
10	Pit	NW¼ NW¼, S 24 T 4, R 15 W.
12	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
14	Pit,	NW¼ NW¼ S 24, T 4, R 15W.
18	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
20	Pit,	NW¼ NW¼, S 24, T 4 R 15 W.
22	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
22-A	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
28	Pit.	SW¼ SW¼, S 13, T 4, R 15 W.
30	Pit,	SW¼ SW¼, S 13, T 4, R 15 W.
31	Pit,	SW¼ SW¼, S 13, T 4, R 15 W.
34	Pit.	SE¼ SE¼, S 14, T 4, R 15 W.
36	Pit,	SE¼ SE¼, S 14, T 4, R 15 W.
38	Pit,	SE¼ SE¼, S 14, T 4, R 16 W.
40	Pit.	SE¼ SE¼, S 14, T 4, R 15 W.
46	Trench	NE¼ NE¼, S 23, T 4, R 15 W.
48	Pit,	NW¼ NE¼, S 23, T 4, R 15 W.
50	Pit,	NW¼ NE¼, S 23, T 4, R 15 W.
51	Pit,	SE¼ SE¼, S 14, T 4, R 15 W.
52	Pit.	NE¼ NE¼, S 23, T 4, R 15 W.
54	Pit.	NE¼ NE¼, S 23, T 4, R 15 W.
56	Trench,	NE¼ NE¼, S 23, T 4, R 15 W.
58	Pit,	NE¼ NE¼, S 23, T 4, R 15 W.
60	Trench,	SE¼ NE¼, S 23, T 4, R 15 W.
64	Pit,	SE¼ NE¼, S 23, T 4, R 15 W.
64	Trench,	SE¼ NE¼, S 23, T 4, R 15 W.
66	Pit,	SE¼ NE¼, S 23, T 4, R 15 W.
67	Pit,	SE¼ NE¼, S 23, T 4, R 15 W.
68	Pit,	SE¼ NE¼, S 23, T 4, R 15 W.
70	Pit,	NE¼ SE¼, S 23, T 4, R 15 W.
72	Trench,	NE¼ SE¼, S 23, T 4, R 15 W.
74	Pit,	NE¼ SE¼, S 23, T 4, R 15 W.
75	Pit,	SE¼ SE¼, S 23, T 4, R 15 W.
76	Pit,	SE¼ SE¼, S 23, T 4, R 15 W.
77	Pit,	NE¼ SE¼, S 23, T 4, R 15 W.
78	Trench,	NE¼ SE¼, S 23, T 4, R 15 W.
79	Pit,	NE¼ SE¼, S 23, T 4, R 15 W.
80	Pit,	SE¼ SE¼, S 23, T 4, R 15 W.
81	Pit,	SE¼ SE¼, S 23, T 4, R 15 W.
83	Pit,	SW¼ SE¼, S 23, T 4, R 15 W.
84	Pit,	SE¼ SE¼, S 23, T 4, R 15 W.
85	Pit,	SW¼ NW¼, S 24, T 4, R 15 W.
86	Trench,	SW¼ NW¼, S 24, T 4, R 15 W.
88	Pit,	SW¼ NW¼, S 24, T 4, R 15 W.
90	Trench,	SW¼ NW¼, S 24, T 4, R 15 W.
91	Pit,	SW¼ NW¼, S 24, T 4, R 15 W.
92	Pit,	SW¼ NW ¼, S 24, T 4, R 15 W.
93	Pit,	SW¼ NW ¼, S 24, T 4, R 15 W.
95	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
96	Trench,	NW¼ NW¼, S 24, T 4, R 15 W.
98	Pit,	NW¼ NW¼, S 24, T 4, R 15 W.
100	Pit,	

SUGGESTIONS AS TO GENESIS

The question of the origin of bauxite is a much discussed one, which has never been explained to the satisfaction of the majority of students of the problem. The writer makes no attempt to offer any explanation to apply to bauxite deposits in general, but confines his discussion entirely to Alabama bauxites. It so happens that all of the Alabama ore bodies are associated with limestones, occupying erosional channels in the underlying limestone and associated with bauxitic clay and clays, sands and often debris. Lignite has been seen in several of the deposits. Over most of the area, particularly in Southeast Alabama, little is seen of the underlying rocks due to deep weathering. It might be noted that all of the deposits occur at or near unconformable contacts, which in most cases represent intervals of long duration. The majority of the ore bodies in Barbour and Henry counties occur near the contact between the Clayton and Nanafalia, where the Sucarnoochee and Naheola are both missing.

The common association of bauxite with brown ore suggests that they were formed under the same general conditions, the variety formed depending upon some slight difference in the source of the material comprising the ores. Many of the bauxites in most of the deposits show important gradations into limonite, and many of the samples of "hard ore" carry iron carbonate (siderite) in its fresh state. The presence of limonite and siderite in and on top of the bodies of bauxite, principally making up the surface and occupying cracks within the bauxite mass, makes it evident that the iron compounds followed the alumina. The total elapsed time between the change is unknown, but it is likely that it was gradual and spread over a considerable period.

The Northeast Alabama deposits are rather difficult to study in detail, but it is evident that they were laid down in old erosional channels and pockets, for the pits which were mined out to a depth of 100 feet or more did not encounter rock during any part of the mining. It is unlikely that weathering alone could have been so complete in its disintegration of the underlying beds. The Margerum deposits show outcrops of limestone in several places adjacent to the bauxite, and it is likely that erosion played a greater part in the formation of these bodies than weathering. The same thing might be said for the Southeast Alabama deposits.

Some of the deposits (e. g., Z—Barbour County) show evidence of bedding, and it is likely that the periods ushering in the deposition or formation of the bauxite found many of the erosional depressions pretty well cleaned out. There must have been a return from strong denudation to swamp and bog conditions, which caused a prompt choking up of these channels with debris. The available supply of coarse material apparently did not completely fill up all of the holes, leaving central areas more or less irregular in shape. Deposition of fine material followed, with the bauxites and bauxitic clays following in turn, and being followed by iron-bearing waters, which filled up the cracks or cavities which remained. Undoubtedly there must have been a long time between the debris and iron ore, allowing for considerable disintegration within the bodies, and subsequent replacement by other material. Some of the ore bodies in the Margerum area show unmistakable signs of alternation of chert and gravel into bauxite, and it is possible that this may have taken place in other districts as well.

The source of the material must have been the land areas adjacent to the deposits, where waters bearing clayey material in suspension and iron and aluminum salts in solution, reached the special swamp conditions where the presence of organic acids caused the precipitation of the iron carbonate and aluminum hydroxide. Carbonic waters likely caused the leaching and alteration in some of the deposits. The exact conditions under which all this took place form the basis for a great divergence in opinion, but it is not necessary to discuss these here.

FUTURE PROSPECTS

The future of the bauxite industry in Alabama is very uncertain, and depends largely upon the development of uses for lower grade material, of which there is an abundance in the State. Heretofore, mining costs have been very high, because only the highest grade ore in each body could be utilized. If the lower grade bauxites and bauxitic clays could be used also, mining costs would be reduced and at the same time much greater reserves would be available. In looking over the pits and dumps, one would wonder whether or not any bauxite was shipped, for the waste would appear to be sufficient to completely fill the hole again. This waste should have some use in a new plan for the utilization of the whole body in clay, bauxitic clay and bauxite.

While the production, which began soon after its discovery in 1889, has scarcely exceeded 20,000 tons in a single year, there has been a rather large total production. There must be sufficient reserves and deposits not yet discovered to make the industry worthy of serious consideration. The wide distribution of the deposits, and the variety of formations enclosing them, should lend encouragement to prospectors, who would certainly have a chance to find additional deposits in the "possible" areas.

The growing demand for high aluminous cements and refractories should provide an outlet for the low grade ores, while the higher quality material always has a ready market.

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